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ABSTRACT

This is one of four major subdivisions of a set of individualized evaluation material for Level II of the Intermediate Science Curriculum Study (ISCS) developed as a part of the ISCS Individualized Teacher Preparation (ITP) program. The manual contains a composite list of selected measurable objectives for Level II of the ISCS program. It is primarily a reference book for persons responsible for examining curricula and determining if this program is likely to meet their school system's objectives and needs. The listed objectives, which are divided into 12 units, are designed to aid in the assessment of students who differ widely in their learning abilities and in the kinds of subject matter which they find difficult. Most units include two chapters and related excursions. Within each unit, the objectives based on the core and remedial excursions of the student materials are listed in the order of their development in the student materials. These are followed by the objectives for the general and enrichment excursions. (Author/HM)

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INTERMEDIATE SCIENCE CURRICULUM STUDY

ISCS

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INDIVIDUALIZED TESTING SYSTEM

Performance Objectives
ISCS LEVEL II

SE 028 466

SILVER BURDETT
GENERAL LEARNING CORPORATION
Morristown, New Jersey · Park Ridge, Ill. · Palo Alto · Dallas · Atlanta

INDIVIDUALIZED TESTING SYSTEM

ALL LEVELS
Individualizing Objective Testing (an ITP module)
Evaluating and Reporting Progress (an ITP module)

LEVEL I
Performance Objectives, ISCS Level I
Performance Checks, ISCS Level I, Forms A, B, and C
Performance Assessment Resources, ISCS Level I, Parts 1 and 2

LEVEL II
Performance Objectives, ISCS Level II
Performance Checks, ISCS Level II, Forms A, B, and C
Performance Assessment Resources, ISCS Level II, Parts 1 and 2

LEVEL III
Performance Objectives, ISCS Level III
Performance Checks, ISCS Level III, ES-WB, Forms A, B, and C
WYY-IV, Forms A, B, and C
IO-WU, Forms A, B, and C
WW-CP, Forms A, B, and C
Performance Assessment Resources, ISCS Level III, ES-WB
WYY-IV
IO-WU
WW-CP

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FOREWORD

To implement an educational approach successfully, one must match the philosophy of evaluation with that of instruction. This is particularly true when individualization is the key element in the educational approach. Yet, as important as it is to achieve this match, the task is by no means simple for the teacher. In fact, without specific resource materials to help him, he is apt to find the task overwhelming. For this reason, ISCS has developed a set of individualized evaluation materials as part of its Individualized Teacher Preparation (ITP) program. These materials are designed to assist teachers in their transition to individualized instruction and to help them tailor their assessment of students' progress to the needs of all their students.

The two modules concerned with evaluation, *Individualizing Objective Testing* and *Evaluating and Reporting Progress*, can be used by small groups of teachers in in-service settings or by individual teachers in a local school environment. Hopefully, they will do more than give each teacher an overview of individualized evaluation. These ITP modules suggest key strategies for achieving both subjective and objective evaluation of each student's progress. And to make it easier for teachers to put such strategies into practice, ISCS has produced the associated booklets entitled *Performance Objectives, Performance Assessment Resources*, and *Performance Checks*. Using these materials, the teacher can objectively assess the student's mastery of the processes, skills, and subject matter of the ISCS program. And the teacher can obtain, at the moment when they are needed, specific suggestions for remedying the student's identified deficiencies.

If you are an ISCS teacher, selective use of these materials will guide you in developing an individualized evaluation program best suited to your own settings and thus further enhance the individualized character of your ISCS program.

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THE ISCS INDIVIDUALIZED TESTING SYSTEM

The ISCS individualized testing system for each level of ISCS is composed of four major subdivisions:

1. The ITP modules *Evaluating and Reporting Progress* and *Individualizing Objective Testing*,
2. *Performance Objectives*,
3. *Performance Checks* in three alternate forms, and
4. *Performance Assessment Resources*.

Evaluating and Reporting Progress presents a comprehensive overview, with many refinements, for individualizing the grading and reporting of students' progress, based on both subjective and objective criteria. The module *Individualizing Objective Testing* describes more specifically those ISCS evaluation materials which have objective criteria – the performance objectives, checks, and resources – and it presents practical suggestions for their use. These two modules should be considered prerequisite to successful use of the other ISCS evaluation materials.

Each of the *Performance Objectives* booklets contains a composite list of selected measurable objectives considered important to a given level of the ISCS program. However, many of the long-range goals and aims that are at the heart of the ISCS program do not lend themselves to being expressed as measurable performance objectives. Thus, these booklets should not be construed as being all-inclusive anthologies of all the possible learning outcomes of ISCS.

Each of three *Performance Checks* booklets contains an equivalent but alternative set of performance checks which were developed to assess the students' achievement of the objectives stated in the *Performance Objectives* booklets.

The *Performance Assessment Resources* booklet is a teacher's handbook to be used in identifying the appropriate performance checks with which to evaluate each student. The booklet also indicates how to set up testing situations, correct responses, and give remedial help.

NOTES TO THE READER

This book is a catalog of the ISCS objectives for Level II. It is primarily a reference book for persons responsible for examining curricula and determining if this program is likely to meet their school system's objectives and needs. As a reference book, it will also be useful to those teachers who wish to write additional objectives or performance checks.

Each objective is written in the formal style described in Excursion 2-1 of the module *Individualizing Objective Testing*. As noted in Chapter 1 of that module, each ISCS objective focuses on a specific, directly measurable student action. The objectives are, in effect, operational definitions of students' abilities; that is, they are statements of how to detect and measure what students can do.

As you might expect, ISCS has other important goals and aims that are not listed in this book. They are missing because they are generally not directly measurable, given the practical confines of time and the state of the art of performance testing and measurement. In many cases, their nature is affective, rather than cognitive, and long-term as opposed to short-term. You will find many of these goals and aims discussed in the module *Rationale for Individualization*.

The objectives in this catalog are designed to aid in the assessment of students who differ widely in their learning abilities and in the kinds of subject matter which they find difficult. As stated in the module *Individualizing Objective Testing*, the key to the successful use of this catalog, the related *Performance Assessment Resources*, and the various *Performance Checks* is selectivity. This catalog of objectives was not designed so that a specific student or group of students would achieve a fixed percentage of them. Probably no one school system and certainly no one teacher will find all of the objectives in this book appropriate. As with a mail order catalog, one must pick and choose according to his needs.

The objectives listed in this book are divided into units. The relationship between the units and the chapters of *Probing the Natural World/2* are shown in Table 1. Most units include two chapters and the related excursions. You will recall that the number preceding the hyphen in the identification numbers for excursions indicates the chapters to which the excursion is related. Within each unit, the objectives based on the core and the remedial excursions of the student materials are listed first and roughly in the order of their development in the student materials. These are followed by the objectives for the general and enrichment excursions.

LEVEL II	
UNIT	CHAPTERS
1	1 and 2
2	3 and 4
3	5 and 6
4	7 and 8
5	9 and 10
6	11 and 12
7	13 thru 15
8	16 and 17
9	18 and 19
10	20 and 21
11	22 thru 24
12	25

Table 1

The two types of code numbers used to identify the objectives in this book and the materials which correspond to each of the objectives in the *Performance Checks* and *Performance Assessment Resources* booklets are shown in Figure 1 below.

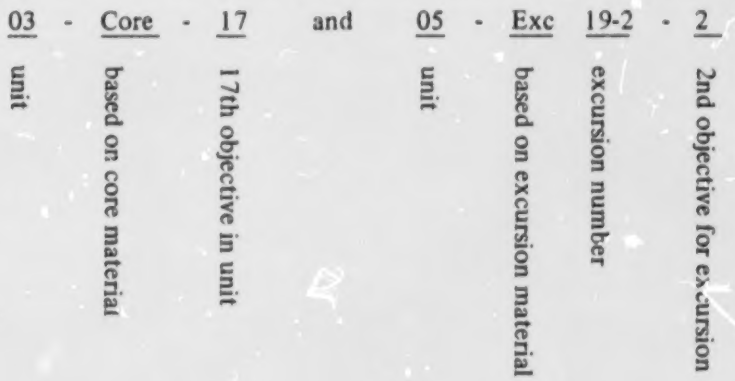
03 - Core - 17 and 05 - Exc 19-2 - 2
unit
based on core material
17th objective in unit
unit
based on excursion material
excursion number
2nd objective for excursion

Figure 1

Given a table listing the physical descriptions of two substances and asked whether they are different substances and to explain his answer, the student applies the concept that physical descriptions alone often do not provide enough information to enable a person to distinguish between substances by responding to that effect. 01-Core-1

When asked to state two things he should do if an unknown or a dangerous chemical spills on him or on a classmate, the student recalls that when an unknown or a dangerous chemical spills on a person, the procedure is to rinse the area with plenty of water, to call the teacher, and, if possible, to show or tell him what chemical it was by so stating. 01-Core-2

Given a dilute acid and a colored, powdered substance and asked to collect the necessary materials and to perform a procedure which involves a risk to the eyes, the student chooses to use safety glasses to protect his eyes while performing a chemical reaction by putting on the safety glasses prior to mixing the reactants. 01-Core-3

Given a bottle of sodium bicarbonate, presented to him as an unknown powder, rock, a bottle of 3M hydrochloric acid, shell, and access to a magnifying glass, safety glasses, a balance, a beaker, and a graduated cylinder and asked if the unknown powder is more like rock or shell and why, the student classifies the unknown powder as being like shell because it reacts with the acid by so stating. 01-Core-4

Given an unlabeled sample of ground-up noncarbonaceous rock, an unlabeled sample of ground-up shell, and a dropper-bottle of 3M HCl and asked to state which sample is ground-up rock and which is ground-up shell and to tell how he knows, the student applies the concept that the chemical properties of a solid substance are the same regardless of the size of the pieces of the solid particles by naming the samples rock and shell accurately and stating the notion that the powders are identifiable because they react like the larger visible pieces of such solids. 01-Core-5

Given a list of four properties of substances, three of which often change with crushing and the fourth being their reaction with acid, and asked which of these properties would change the least if the substance were ground to a powder, the student applies the concept that the reactions of substances are independent of particle size by selecting the entry which indicates the reaction with acid. 01-Core-6

01-Core-7	When asked to draw a diagram to illustrate what he would expect to see if a piece of a specific substance were magnified several billion times and to explain his diagram, the student applies the particulate model of matter by drawing a diagram that indicates numerous small particles and stating the effect of the concept of the particulate model of matter.
01-Core-8	Given a list of four sources for the models of science and asked to identify where scientific models come from, the student recalls that the models of science are created in people's minds by selecting the entry to that effect.
01-Core-9	Given a list of five statements about matter particles, three of which are assumptions of the particle model for matter, and asked to identify those which are part of that model, the student classifies statements to the effect that matter particles move, are closest together in solids, have energy, and make up all matter and that heat energy increases the motion of the particles as assumptions of the particle model by indicating at least two of the three correct entries and not more than one inappropriate entry.
01-Core-10	Given four statements concerning scientific models and asked to select the best description of scientific models, the student applies the concept that scientific models are better described as useful than as correct by selecting the statement that exemplifies that concept.
01-Core-11	Given four statements, three of which are characteristics of a scientific model and one of which is not, and asked to select the statements which are true of a scientific model, the student classifies as the characteristics of a scientific model that it explains observations, it can include a physical object or a set of objects, and it can be a mental picture by selecting at least two of the three correct statements and not the incorrect statement which indicates that it is an observation.
01-Core-12	Given a list of eight substances, including at least two in each state of matter, and asked to classify them according to the state of matter in which they exist at room temperature, the student classifies each substance as existing at room temperature as a solid, a liquid, or a gas by labeling at least six of the eight substances correctly.

When asked to state two things a scientific model does, the student recalls that a scientific model (1) suggests important questions, (2) explains previously made observations, (3) suggests new experiments, and (4) predicts the nature of the results of new experiments by stating the notion of two of the above four. 01-Core-13

When asked to state a definition for *mass*, the student recalls the definition that mass is the quantity of matter in an object by responding to that effect. 01-Core-14

Given a list of five entities, at least one of which is composed of matter, and asked to put an M after those things which are made up of matter and to put a P after those things which are composed of particles, the student applies the concept that anything made up of matter is made up of particles by designating those that he has labeled as being made up of particles, and only those, as being composed of matter. 01-Core-15

Given a list of five entities, at least one of which is matter, and asked to put an M after those things which have mass and to put an X after those things made up of matter, the student applies the concept that all things composed of matter have mass by designating those and only those he labels as being composed of matter as having mass. 01-Core-16

Given a statement that a particular gas is matter and asked what he would have to show about the gas to prove that it is matter, the student applies the definition that matter is anything that has mass by responding that he would have to show that the gas has mass. 01-Core-17

Given a double-pan balance, a set of standard masses, and two objects, each of whose mass is within the range of the balance used, and asked to measure the mass of each of the specified objects, the student manipulates the balance and the standard masses to measure the mass of each of the specified objects by stating the mass of each object accurately to within ± 0.5 gram. 01-Core-18

Given a volume in cubic centimeters and asked to state the volume in milliliters, the student applies the rule that one cubic centimeter equals one milliliter by responding with the same number stated in milliliters. 01-Core-19

Given a graduated cylinder and an unknown volume of liquid which exceeds the capacity of the cylinder and asked to report the 01-Core-20

volume of the liquid, the student applies the procedure for finding the volume of a liquid using standard metric units by measuring and reporting the volume within 5% of the value established by the teacher.

01-Core-21 Given a description of an inflated object and asked if the gas inside the object is matter and to defend his response, the student classifies a gas as matter by responding affirmatively and stating either that it has mass or that it occupies space or both.

01-Core-22 Given a large beaker of water and an air piston, a small beaker, or a dropper and the directions to fill the piston, beaker, or dropper with air and then put it into the water and create bubbles and asked to identify the state of the matter coming out of the device, the student recalls that the matter inside a bubble is in the form of gas by responding to that effect.

01-Core-23 Given a rough diagram of his science classroom or lab in a location other than that room and asked to identify the usual locations of safety equipment, including sand, the fire blanket, safety goggles, the fire extinguisher, and the first-aid kit, the student recalls the locations of the safety equipment by indicating on the diagram their normal position in the room.

01-Core-24 Given ample opportunity to work with materials on a laboratory activity of more than one day's duration and asked to observe the cleanup period at the appropriate time, the student chooses to close the laboratory activity period promptly upon receiving notification of the time by immediately ceasing the laboratory activity, returning materials in usable, clean condition to storage places, and participating in work area cleanup, on at least three separate occasions when being observed by the teacher without his knowledge.

01-Core-25 When asked to work in the laboratory with fellow students, the student chooses to cooperate with fellow students in the laboratory by being polite, waiting his turn, being orderly when moving about, and observing the right of his classmates to work without being unnecessarily disturbed, when observed without his knowledge by the teacher or another designated person on at least three occasions.

01-Core-26 When asked to work with the equipment and text materials of the ISCS course, the student chooses to show personal responsibility for returning laboratory equipment no longer needed to the proper storage places during the activity period by returning such equipment and materials to the designated storage places on at least

three occasions when observed by the teacher or another designated observer without his knowledge of being checked.

As asked in the "Notes to the Student" section of *Probing the Natural World/2* to respond in writing to all of the questions in his *Record Book*, the student chooses to write in his *Record Book* his answers to 90% or more of the questions in his textbook by exhibiting the written responses when the teacher spot checks to determine if he is doing so. — 01-Core-27

When working independently in the laboratory, the student chooses to show proper care and use of ISCS laboratory materials by using the materials only for their intended purpose or by requesting permission to do other specific experiments with them, when being observed without his knowledge by the teacher or another designated person on three or more occasions. — 01-Core-28

Given a list of English and metric units and a list of quantities of measurements and asked to match the proper units in the metric system to the quantities they measure, the student classifies the units that are used to express quantities of measurement in the metric system by matching the metric units to the quantities they express in the metric system in at least four of six cases. — 01-Exc 2-2-1

Given a description of a situation in which he is on an unknown planet and asked to name two things which would determine weight on that planet, the student recalls that the weight of an object depends on (1) the mass of the object, (2) the mass of the planet, and (3) the distance from the center of the planet to the object by stating the essence of two of these. — 01-Exc 2-3-1

Given a list of four physical properties of a solid and asked which of them depends upon location, the student recalls that weight is dependent upon location by selecting that option. — 01-Exc 2-3-2

Given a list of items and asked which factors determine his weight on earth, the student recalls that the important factors determining an object's weight are the earth's mass, his mass, and his distance from the center of the earth by selecting the entry involving those notions. — 01-Exc 2-3-3

Given two small transparent jars, one filled with a solid or a liquid and capped and the other with air in it and uncapped, and asked to identify the state of the matter, if any, in each of the jars, the student classifies air as a gas at room temperature by stating that the uncapped jar contains a gas. 02-Core-1

Given a description of a situation in which two people report different results for what is claimed to be the same experiment and the argument that at least one of the experimenters must not have done what he claimed to have done and asked whether or not they did the same experiment and to explain his answer, the student applies the concept that when two sets of experimental conditions are identical, the same results are obtained by responding negatively and with the notion of that concept. 02-Core-2

Given a description of a situation in which a student won't draw a conclusion based on one test and asked whether or not the student's action should be accepted and to state a reason for accepting or not accepting it, the student applies the concept that one valid test often does not provide enough evidence for drawing a conclusion by responding affirmatively and with the notion of that concept. 02-Core-3

Given an operational definition from the text for one of three gases -- carbon dioxide, hydrogen, and air -- and asked if the gas could also be operationally defined as odorless, colorless, and tasteless and to explain his answer, the student applies the concept that an operational definition for a substance states a procedure for detecting that substance by a property or set of properties unique to it by responding negatively and to the effect that the proposed definition includes other gases, not just the one being defined. 02-Core-4

Given the names of two fictitious gases, four reactions, three of which are alike, and an operational definition for one of the gases written in terms of the three similar properties and asked if the operational definition is a good one and to explain his answer, the student applies the concept that an operational definition must include a property or set of properties unique to the substance being defined by responding negatively and with the notion of the concept. 02-Core-5

Given a list of four definitions of specific substances, two of which are operational definitions, and asked to select the operational definitions in the list, the student classifies any state- 02-Core-6

	ment which tells how a substance can be detected as an operational definition of the substance by selecting both operational definitions.
02-Core-7	Given a list of facts about a substance, including a procedure for detecting it, and asked to select the statement that operationally defines the substance, the student applies the concept that a test or set of tests specific to a substance is an operational definition for it by selecting the statement that describes a way to detect the substance.
02-Core-8	Given a description of a situation in which two different substances yield identical results when each undergoes the same two chemical tests and asked to give a reason for the similar results, the student applies the concept that different substances may contain the same kinds of matter particles and thus would yield similar results to the same tests by responding with the essence of that concept.
02-Core-9	Given a list of four gases — carbon dioxide (CO_2), hydrogen (H_2), air, and an unknown gas — and a table which indicates the results of testing each of the four gases with limewater, phenol red, and a burning match and asked to identify each of the gases on the basis of its characteristics, the student classifies the gas which turns phenol red to yellow, turns limewater cloudy, and does not support combustion as CO_2; the gas which does not change either the phenol red or the limewater, but supports combustion as air; the gas which does not change phenol red or limewater, but explodes in a flame as H_2; and the gas which turns phenol red clear, does not react with limewater, and does not support combustion as the unknown gas by matching the gases with those characteristics.
02-Core-10	Given a word statement of a chemical reaction and asked to identify the reactants and the products, the student classifies those substances written to the left of the *yields* symbol (→) as reactants and those substances written to the right of the *yields* symbol as products by naming the appropriate substances as reactants and products.
02-Core-11	Given a description of a chemical reaction which names the reacting substances and the products formed and asked to write a word statement for the chemical reaction, the student applies the conventions that products are written to the right of the *yields* symbol, that reactants are written to the left of it, and that each of the products and each of the reactants is linked to the

others by a *plus* symbol by writing the word statement in such a manner as to include all of those conventions.

Given a list of five entities, at least three of which are gases, and asked to indicate those things which are gases and those things which are matter, the student applies the concept that gases are matter by labeling as matter anything he labels as a gas. 02-Core-12

Given four reactions, all involving a common reactant reacting with different materials, in which three of the reactions produce a product that appears to be the same but which additional testing shows to be different in one of the three cases and a table showing the observations of the additional testing and asked which of the different original reactants are likely to contain the same type of matter particle, the student applies the concept that a set of substances producing the same product when reacting with a common reactant is evidence that the set of substances all contain a common matter particle by selecting the original reactants which react with a common reactant to produce a common product as probably containing the same type of matter particle. 02-Core-13

Given descriptions of four situations, including one in which a control is used, and asked to identify the situation in which a control is used, the student classifies as a control that portion of the sample to be tested which is subjected to all the experimental conditions except the variation of the variable being examined by selecting the situation in which a control sample is used. 02-Core-14

When asked to give a definition of *control*, the student recalls the definition that a control is a sample equivalent to the sample being tested to which all the same experimental conditions are applied except the variation of the variable being studied by responding to that effect. 02-Core-15

When asked to give a reason for using a control in an experiment, the student recalls that a control is used in an experiment to help identify the variable which is most related to the resulting event or substance by responding to that effect. 02-Core-16

Given a hypothetical situation in which an unknown material is presented to him and asked how to determine what matter particles make up the material, the student recalls that matter particles in a substance can be identified by using chemical tests on the substance by stating the notion of that fact. 02-Core-17

02-Core-18	Given the names of two indicators and the particles they identify, the results of using the indicators on each of four solutions, and a list of four conclusions about the solutions, only one of which is supported by the data, and asked to select the conclusion consistant with the data, the student classifies the matter particles present in solutions by their reactions with the specified indicators by selecting the conclusion which is consistent with the information about the indicators and the data.
02-Core-19	Given the statement that there are one trillion known materials and asked if the number of different kinds of matter particles is greater than, less than, or equal to one trillion and to state evidence which supports his choice, the student applies the concept that the number of different kinds of matter particles is less than the number of known materials by stating that there are fewer kinds of matter particles than kinds of materials and citing in evidence that many of the materials he has tested contain the same matter particles.
02-Exc 3-1-1	Given data from Excursion 3-1 about the reactions of hydrochloric acid (HCl), lemon juice, and vinegar with a carbonate and asked what this tells him about the HCl, lemon juice, and vinegar, the student applies the concept that if a set of substances produces the same product when reacting with the same reactant, that is evidence that the set of substances all contain a common matter particle by stating that the three given solutions probably all contain a common matter particle.
02-Exc 4-1-1	Given a line of inquiry for which an experiment is to be proposed to answer a question and asked to select the variable whose variation is to be studied, the student applies the concept that in an experiment there is a factor whose variation is being studied as a result of the changes of the independent variable by selecting the variable to be studied.
02-Exc 4-1-2	Given a problem and asked to state two variables other than the independent variable which must be controlled if the results of an experiment are to be valid, the student applies the concept that in experimental situations there are factors other than the independent variable whose variation must be controlled if the data are to be interpretable by naming two such factors.
02-Exc 4-2-1	When asked to describe a more sensitive test for iodine than that of observing the gas produced when an iodine-containing substance is heated, the student recalls that a sensitive test for iodine involves (1) adding a chlorine solution and mineral oil to a

solution of the compound which may contain iodine and (2) shaking the mixture until the released iodine turns the mineral oil pink by responding in his own words with a description of those two operations.

Given the statement that thousands of substances produce the same products when burned and asked what conclusion he can make about the composition of these substances, the student applies the concept that a set of substances reacting with the same reactant to produce the same products is evidence that all of the substances contain the same elements by responding to that effect. 02-Exc 4-3-1

Given a list of five entities, at least one of which is composed of matter, and asked to indicate both those things which are made up of matter and those things which are made up of elements or combinations of elements, the student applies the concept that all that which is matter is made up of elements or combinations of elements by designating all entries that he has labeled as being composed of matter as also being composed of elements or combinations of elements.	03-Core-1
When asked to state the scientific term for substances which are made up of a single kind of atom, the student recalls that elements are substances made up of a single kind of atom by responding with the term *element*.	03-Core-2
When asked to name the particles which make up an element, the student recalls that atoms are the particles which make up an element by responding with the term *atoms*.	03-Core-3
Given four diagrams in which different symbols represent different kinds of atoms and asked to select the diagram which best represents an element, the student applies the concept that an element is composed of one and only one kind of atom by selecting the diagram containing only one symbol.	03-Core-4
Given a list of five entities, at least one of which is composed of matter, and asked to designate which entities are made up of matter and which entities are made up of atoms, the student applies the concept that all that which is matter is made up of atoms by designating all entries which he has labeled as being composed of matter as also being made up of atoms.	03-Core-5
Given a specified number of elements and asked how many different atoms are present in these elements, the student applies the concept that there is a unique kind of atom for each element by responding with the same number of atoms as there are elements given.	03-Core-6
Given four numbers differing at least by an order of magnitude and asked how many known substances cannot be broken down into other substances by ordinary chemical means, the student recalls that there are about one hundred substances which cannot be broken down into other substances by ordinary chemical means by selecting the entry which states that there are about 100 elementary substances.	03-Core-7

03-Core-8	When asked to illustrate what he might see if a piece of a specified element were magnified so that its atoms were visible and to explain his illustration, the student applies the concepts that atoms are matter particles and that an element is composed of a single kind of matter particle by drawing a diagram that indicates small particles identical in size and shape and explaining the concepts.
03-Core-9	Given the formula for a compound and a symbol for a specific element in the compound and asked to state how many kinds of atoms (matter particles) are represented by that symbol, the student applies the concept that the symbol for an element stands for just one kind of atom by so responding.
03-Core-10	Given a description of a set of nuts and bolts, their symbols, the number of units of each present in a combination, and a list of five formulas and asked to select the formula which represents the given combination, the student applies the conventions for stating a formula that the symbol of each element in the combination is shown and the number of units of each kind of particle present in a combination is either indicated as a subscript after the symbol of the particle to which it refers or not shown if there is only one unit of that particle in the combination by selecting the correct formula.
03-Core-11	Given the symbols for two types of nuts and two types of bolts and four formulas involving these symbols and asked to state the total number of particles represented in each formula, the student applies the concept that in a formula, a symbol represents a single particle and a subscript after the symbol indicates the presence of two or more particles of that type by responding correctly in three of the four cases with the sum of the subscripts, having assumed any unwritten subscripts to be one.
03-Core-12	Given a nut and bolt formula with a coefficient and identification of the symbols used in the formula and asked how many particles of a particular kind are present in a unit of the combination, how many units of the combination are shown, and how many particles of a particular kind are present in the total number of units of the combination, the student applies the conventions of numeration in a formula that a subscript following a symbol shows the number of particles of that kind present in one unit of the combination, that the coefficient represents the number of units of the combination, and that the mathematical product of the coefficient and subscript is the total number of particles of a particular kind in the total combination by stating at least two of the three numbers correctly.

Given two formulas and asked how many different kinds of particles each formula represents, the student applies the rule that the number of kinds of particles represented in a formula is the same as the number of different atomic symbols by stating the correct number in both cases. 03-Core-13

Given a key for the symbols for two kinds of pins and two kinds of buttons and diagrams of two combinations of these pins and buttons and asked to write the formulas for the combinations shown, the student applies the conventions of chemical formula writing that the elements present are represented by their symbols and that if the number of atoms of an element in the combination is greater than one, the number of atoms is denoted by a subscript after the symbol of the element to which it refers by so writing the formulas for the pin-button combinations given. 03-Core-14

Given a graphic representation of a chemical reaction which uses pins and buttons and asked to describe the reaction in terms of symbols and numbers, the student applies the conventions of chemical formula writing by using the proper symbols and by placing the number of specific units before the symbols of the particles in the unit and the number of a specific type of particle within a unit as a subscript after the symbol that represents the particle by writing such a number and symbol description of the reaction. 03-Core-15

Given a nut and bolt (molecular) formula and asked to use the formula to state the order and the spatial arrangement of the particles in the combination, the student applies the concept that a chemical (molecular) formula does not give the order of the atoms by responding to that effect. 03-Core-16

Given options of three numbers between one and eight, a combination of two of these, and a combination of all three and asked to select the option which represents the numbers of kinds of atoms that a given substance may contain, the student applies the concept that it is possible for a substance to be composed of one or more kinds of atoms by selecting either all the numbers given or the option which includes all three. 03-Core-17

Given a description of a situation and statements of two positions -- (1) that each of the millions of existing substances is composed of a unique element (particle) and therefore the elements in a particular specimen are impossible to identify and (2) that it is possible to identify the elements in any substance -- and asked which position he agrees with and to explain why that posi- 03-Core-18

	tion is correct, the student applies the concept that all matter is composed of about one hundred elements or combinations of them by agreeing with the second position stated above and explaining that the variety results from the many combinations that can be made from approximately one hundred elements.
03-Core-19	Given that the atomic model assumes all substances to be made from a small number of different kinds of particles and asked how this can be true, the student recalls that the many known substances are made from a small number of different kinds of particles in different combinations by stating the effect of that notion.
03-Core-20	Given a description of three substances, each dissolved into a liquid, and asked what term describes the resulting mixture, the student classifies as solutions mixtures formed when one substance dissolves into another by responding with the term *solution*.
03-Core-21	When asked what happens to a given solid substance when it is stirred with a clear liquid and disappears, the student recalls that a solid substance dissolves, or goes into solution, when it disappears in a liquid by responding to that effect.
03-Core-22	Given the mass of both a liquid and a dry solid and the mass of a solution and asked if the number of atoms increased, decreased, or remained the same when the components of the two were put into solution and to explain his answer, the student applies the concept that if the mass of a material which undergoes a physical change remains constant, the number of atoms in the material is unchanged by selecting the phrase which indicates that the number of atoms remains unchanged and stating the effect of the concept.
03-Core-23	Given a description of a situation in which a sample taken from a beaker of liquid proves to contain a dissolved substance and asked whether other samples from the beaker could differ and to explain his answer, the student applies the concept that a solution is uniform throughout and therefore all other samples would contain the same substances by responding negatively and in effect that all samples would contain the dissolved substance because a solution is uniform throughout.
03-Core-24	Given a sample of a solid and asked to heat it and to record any changes that take place, the student applies the safety rules for heating a substance in a test tube by pointing the test tube away from himself and other students, using a test tube clamp, moving the test tube back and forth in the flame, and wearing safety glasses.

Given a description of a chemical reaction in which the products are visibly very different from the reactants and asked what happened to the atoms of the reactants to make this so, the student applies the concept that a chemical reaction is a process in which the atoms of the reactants are recombined in new combinations by responding to that effect. 03-Core-25

Given a description of a situation in which two elements, one of which is known to be very active and one about which nothing is known, are heated and no reaction occurs and the conclusion that the unknown element won't react with any element because it does not react with the active element and asked to state whether he agrees with the conclusion and to support his response, the student applies the concept that individual elements do not necessarily react with all other elements by responding to the effect that he disagrees with the conclusion and stating the notion of the concept. 03-Core-26

Given a reaction, the number of atoms of a specified element in the reaction, and five numbers, including the number of atoms of the element that reacted, and asked how many atoms of the reacting element are found in the products, the student applies the concept that the number of atoms of an element remains unchanged during a chemical reaction by selecting the same number of atoms known to be present in the reactants as the number present in the products. 03-Core-27

Given the statement that solutions of AB and CD react to form a solid BC and asked to state a way to tell whether all the atoms of C are used up in the reaction, the student applies the procedure for determining whether the atoms of a specified reagent are used up in a chemical reaction by responding to the effect that he would add more of the reagent AB and if more BC forms, he would know that the C atoms are not used up. 03-Core-28

Given the equation for a chemical reaction and the total mass of the products formed and asked to tell whether the total mass of the reactants used was greater than, equal to, or less than the mass of the products and to explain how he knows, the student applies the rule that in a chemical reaction, the mass of the products is equal to the mass of the reactants by selecting the option which says that the mass of the reactants is equal to the mass of the products and stating the essence of the rule. 03-Core-29

Given a list of nine legitimate statements about how the elements were named and the statement that the elements were named systematically and asked to select all the statements which account for 03-Exc 5-1-1

the variety of element names, the student applies the concept that the wide variety of kinds of names of the elements is the result of using many name sources and not the result of a deliberate, systematic naming process by rejecting the statement that the elements were systematically named and selecting any five or more of the other statements.

03-Exc 6-1-1 Given a description of a situation in which a known number of particles of a substance are dissolved in a known volume of a liquid and asked how many particles would be found in a small sample of a given volume of the solution and to tell how the particles are distributed in the solution, the student applies the concept that when a substance dissolves in a liquid, the particles of the substance are distributed evenly throughout the liquid by determining the proportionate number of particles in the small sample and stating the concept.

03-Exc 6-2-1 Given descriptions of four situations, each of which describes any changes which take place when solutions of two materials at the same temperature are mixed, and asked for each situation whether a chemical reaction has occurred and to tell how he knows, the student applies the rule that a chemical reaction has occurred when two or more substances are mixed with one or more of the following results -- (1) the color changes, (2) a gas is formed, (3) a solid is formed, or (4) the temperature changes — by responding that a chemical reaction has occurred in cases in which at least one of those changes is observed and by citing for each case any of the changes which occurred.

03-Exc 6-3-1 Given a statement concerning two solutions, AB and CD, which reacted to form a solid AD and asked to describe a method to tell whether all the D atoms are used up in the reaction, the student applies the laboratory procedure for determining whether or not the atoms of a reagent are used up in a chemical reaction by responding to the effect that he would add more AB and if more precipitate formed, the D atoms were not used up.

Given two equations, each involving the reaction of a different set of two elements to form compounds, and four additional equations, representing hypothetical reactions and using the elements from the original equations, and asked if he agrees that because the two original sets of elements reacted, that the four hypothetical reactions therefore must occur, and why, the student applies the concept that not every element combines with every other element by disagreeing with the stated position and stating the notion of the concept. 04-Core-1

Given five plausible answers to a problem in which the volumes of two samples (A and B) of a solution and the number of atoms of the solute in the smaller sample (A) are specified and asked to select the number of atoms of the solute in the other sample (B), the student applies the concept that the ratio of the atoms in two samples of a solution is in the same ratio as their volumes by selecting the answer given by the following formula:

$$\frac{\text{specified volume of unknown}}{\text{specified volume of known}} \times \frac{\text{known number of atoms}}{} = \frac{\text{unknown number of atoms}}{}$$

04-Core-2

Given a description of a reaction which includes the number of particles reacting and the units of product and the number of particles of one of the reactants for a second case and asked if the number of particles of the other reactant and the number of units of product can be predicted for the second case and to explain his answer, the student applies the law of definite composition (combining proportions) that in compounds the atoms of different elements are combined with each other in definite ratios (numbers) by responding affirmatively and stating the effect of the law. 04-Core-3

Given four nut and bolt combinations involving just one type of nut and one type of bolt, the elements which they represent, and the fact that equal volumes of two solutions of equal concentration of the specified atoms are reacted and asked which combinations would lead to the prediction that there will be excess particles of a specified element, the student generates correct predictions of excess particles from the nut and bolt combinations by selecting those and only those combinations from which excesses can be predicted. 04-Core-4

Given a statement that two solutions, AB and CD, react to form a solid AD and asked to state a way to determine if all the D atoms of solution CD are reacted in the reaction, the student applies the procedure for determining whether or not the atoms of a specified reagent are used up in a chemical reaction as adding 04-Core-5

more of the other reagent or reagents and looking for evidence of further reaction by responding to the effect that he would add more AB, and if more solid forms, the D atoms were not used up.

04-Core-6 Given a quotation from Chapter 7 of the text, describing an experiment which instructs that measurement must be made quickly to avoid a change in the product, and asked to state the variable that these directions are telling him to control if his results are to be valid, the student classifies time as the variable whose variations must be controlled if the data are to be valid by stating that time is the variable in question.

04-Core-7 Given a statement that a solution of A is added to a solution of B which react to form a gas and asked to describe a method for telling if all the B particles are used up in the reaction, the student applies the procedure of adding more of the other reagent to determine if the particles of a reagent are used up in a gas-producing chemical reaction by responding to the effect that he would add more of reagent A; if more gas forms, the particles of the reagent (B) being checked are not used up.

04-Core-8 Given an appropriately labeled grid and a data table for six reaction trials of a single chemical system involving two reactants, showing for each trial the varying amounts of reactant A which are mixed with a fixed amount of reactant B and the amount of product formed in each case, and asked to state for each reactant in which trials it is in excess, the student applies the rule of definite combining numbers (ratios) -- when a reactant has been exhausted by combining in a definite proportion, the reaction stops -- by selecting the cases in which reactant B is in excess as those cases in which a fixed increase in the amount of reactant A produces a proportional change in the amount of the product and the cases in which reactant A is in excess as those in which the proportional difference in the amount of product is not observed for a fixed amount of increase for reactant A.

04-Core-9 Given a statement that substance X is a compound and asked to define *compound* as it is used in the sentence, the student recalls the definition that a compound is a substance which is composed of more than one kind of atom combined in definite numbers by writing the definition of *compound*.

04-Core-10 Given pictures of two pin and button combinations identified as representing compounds and a table of the individual pin-button symbols and asked what each of the four individual symbols represents, the student classifies the individual pins and buttons

in the graphic representation of a compound as representing the elements or atoms which make up the compounds by responding either "element" or "atom."

Given a description of a situation in which a scientific model explains all the observations made to date about a certain phenomenon and the developer's claims that all other proposed models are wrong and asked if he agrees or disagrees with the developer and to explain his answer, the student applies the concept that there can be more than one model for a set of observations by disagreeing and stating the concept. 04-Core-11

Given a story in which all the atoms in a material are exactly alike and asked to state the kind of material involved in the story, the student classifies matter which is composed of one and only one type of atom as an element by so stating. 04-Core-12

Given four statements purporting to be characteristics of the models of science and asked to select the statement that best describes scientific models, the student recalls that the models scientists use are better described as useful than as correct by selecting the statement that agrees with that concept. 04-Core-13

Given five possible interpretations of what it means for a model to be accepted by scientists and asked to select the best interpretation, the student applies the concept that acceptance of a model implies only that it explains most observations made to date by selecting the entry involving explanation or observation. 04-Core-14

When reminded that the text asked in Chapter 7 and again in Chapter 8 whether atoms combine with each other in definite numbers and asked why it was necessary to answer the same question twice, the student applies the concept that a single case often does not give sufficient evidence upon which to base a conclusion by responding to that effect. 04-Core-15

Given a chemical equation labeled as a system and a list including two subsystems, two components, and the entire system and asked to indicate which of the listed entities are components of the system, the student classifies individual elements or compounds as components of the system by selecting the two components. 04-Core-16

Given a chemical equation labeled as a system and a list including three subsystems, one component, and the entire system and asked to indicate which of the listed entities are subsystems of the 04-Core-17

system, the student classifies as a subsystem a group of components or a part of a system being isolated for study by selecting at least two of the three groups of components which are less than the whole system.

04-Core-18 Given access to an alcohol burner, a 250 ml beaker, a burner support stand, a Celsius thermometer, and water and asked to record the temperature of a specified amount of water every minute while heating it for three minutes, the student manipulates the thermometer, using the accepted procedure of (1) placing the thermometer into the water so that it does not touch the bottom of the beaker, (2) waiting for the fluid in the thermometer to adjust, (3) putting his eye level with the top of the fluid when taking a reading, and (4) reading the temperature with the bulb of the thermometer submerged by performing these operations and reporting the temperatures to within 1°C of the values read by an observer.

04-Core-19 Given a description of a situation in which an empirical ratio for the atoms of two elements is given and asked if he agrees either that (1) the combining ratio for these two elements remains constant whenever these elements react or that (2) the ratio varies with the initial quantities used in each trial and to explain his choice, the student applies the rule that atoms combine in definite numbers (ratios) by indicating that he agrees with the rule that atoms combine in definite numbers (ratios) and by stating the essence of the rule.

04-Core-20 Given access to a double-pan balance, a gram mass set, sheets of paper, a wood splint, and a granular material and asked to measure out X grams of the material, the student manipulates the materials according to the procedure in which he (1) places approximately equal amounts of paper on both balance pans, (2) zeroes the balance, (3) places the X-gram mass on the paper in one pan, (4) deposits the solid a little at a time on the paper in the other pan until the pointer is at the zero position, and (5) removes the papers and gram masses by performing each step, as indicated, to the satisfaction of the observer.

04-Core-21 Given access to 5 stirring rods, 5 test tubes, and a series of solutions and the directions to mix five combinations of them in different test tubes and asked to state for each mixture whether a chemical reaction has taken place and to give evidence of reaction when it occurs, the student applies the concept that when two solutions are mixed, there is evidence that a chemical reaction has taken place if (1) the temperature changes, (2) the color changes, (3) a gas is released, or (4) a precipitate is

formed by indicating that a reaction has occurred when one of those is observed and by citing the observed evidence.

Given descriptions of four situations, including any changes which take place when two solutions at the same temperature are mixed, and asked in each case to tell whether a reaction has occurred and to cite evidence of a reaction where it occurs, the student applies the rule that when two or more substances are mixed, there is evidence that a chemical reaction has occurred if at least one of the following occurs: (1) the temperature changes, (2) the color changes, (3) a gas is formed, or (4) a precipitate is formed by stating whether or not a reaction has occurred and by citing any of those characteristic changes as evidence of the reaction. 04-Core-22

Given a description of three trials, each involving the addition of a fixed amount of reactant A to three samples of reactant BC whose masses are sufficient to produce leftover C atoms and the masses of the product AC and asked why the amounts of product AC are the same in each trial, the student applies the concept that substances combine chemically in definite numbers (ratios) by responding to the effect that the amounts of the product AC are the same in each trial because the amounts of reactant A used are the same in each trial and reactants always combine in definite numbers (ratios). 04-Core-23

Given the name and the symbol of a variable and asked what he would measure if he were asked to measure $\blacktriangle variable$, the student classifies the measurement of $\blacktriangle variable$ as the measurement of a change in the variable by so stating. 04-Core-24

Given the statement that two solutions, A and C, reacted to produce a temperature change and asked to describe a method to tell if all the C particles were used up in the reaction, the student applies the procedure of adding more of the other reagent or reagents to determine whether the particles of a reagent are used up in a chemical reaction which gives off heat by responding to the effect that he would add more of the reagent not being tested for (A) and if a further temperature increase results, he knows the C particles were not used up. 04-Core-25

Given three samples containing two elements and the ratios of different atoms within two subsamples from each of the three samples, the ratio of atoms of one element in a subsample to those of the other being different for two of the three samples and identical in the third sample, and asked which of the three samples represents a single compound and how he knows, the student applies 04-Core-26

	the concept that when elements combine to form a compound, they combine in definite numbers (ratios) by selecting only the sample whose subsamples have identical numbers (ratios) and stating the essence of the concept.
04-Core-27	Given a balanced equation written in symbols and words and asked how many atoms of each of two specified elements are present either in the reactants or in the products, the student applies the rule that the number of atoms of an element (X) in a specified number of units of a formula ($4X_2Y$) is the product of the coefficient (4) of the formula and the subscript after the element (2) by responding with the indicated product.
04-Core-28	Given a list of visual observations made before and after a reaction involving two solutions and the particles in the reactants and asked what occurred during the reaction to cause these changes, the student applies the concept that in a chemical reaction the particles of the reactants are recombined to form different substances (the products) by responding with that notion.
04-Core-29	Given an equation for a reaction in which the products contain elements not present in the original reactants and asked if the reaction is possible and to explain his answer, the student applies the rule that in ordinary chemical reactions, elements in the reactants and products are the same by responding to the effect that the reaction could not occur because there are elements in the products that are different from those in the reactants.
04-Exc 7-1-1	Given a graph of the amount of a product plotted against the amount of a reactant and asked which, if either, of two extrapolated values, one just beyond and a second considerably beyond the range of the data plotted, is less reliable and why, the student applies the concept that extrapolated values which are considerably beyond the ranges of plotted data are of more questionable reliability than values nearer the given data range because the relationship between the variables may change over the wide range by indicating the extrapolated value farther from the plotted data to be weaker and stating the notion of the concept.
04-Exc 7-1-2	Given a grid with labeled and scaled axes and six coordinate pairs in the form of a data table and asked to plot the data and draw the best-fit lines, the student applies the process of plotting the points on a grid and drawing the best-fit lines by

plotting the points and drawing the lines such that the graph shows the intersection of two straight lines.

Given six graphs and asked to select those graphs which show that when one variable increases, the other variable also increases, the student classifies graphs whose lines rise from left to right as graphs showing the relationship between two variables that vary with one another by selecting the graphs whose lines rise from left to right. 04-Exc 7-1-3

Given six straight-line graphs and asked to select all the graphs which show one variable remaining constant while the other increases, the student classifies graphs with a straight line parallel to one of the axes as those in which one variable remains constant while the other increases by selecting those graphs. 04-Exc 7-1-4

Given a graph of the amount of product versus the amount of reactant and asked to extrapolate and interpolate values of one of the variables when given values of the other, the student applies the procedure for extrapolating and interpolating from a graph by reporting the coordinate values asked for to ± 0.5 of a scale interval of the graph. 04-Exc 7-1-5

Given five beakers containing equal volumes of water and varying amounts of solute and asked to order the solutions according to their concentrations, starting with the least concentrated, and to indicate which of two specified solutions has the greater concentration, the student classifies the solutions according to their concentration (the amount of solute per unit of solvent) by ordering them according to increasing concentration and indicating that the solution containing the higher number of grams of solute is the more concentrated. 04-Exc 7-2-1

Given a volume of solution and the number of grams of solute in the solution and asked to state the concentration in g/ml, the student applies the rule that to find concentrations, divide the weight of the solute by the volume of the solution and report the answer in g/ml by stating the concentration correctly. 04-Exc 7-2-2

Given the total volume of a solution and the number of grams of solute in that total volume and asked to state the number of grams of solute present in a stated sample of the total solution, the student applies the formula that grams of a solute in X volume of a solution equals X volume of the solution divided by the total 04-Exc 7-2-3

volume of the solution times grams of the solute in the total solution by reporting the number of grams of solute determined by substituting the values of the problem in that equation.

04-Exc 8-1-1 Given a 250 ml beaker, a Celsius thermometer, and water and asked to record the temperature of the water, the student manipulates the thermometer using the accepted procedure of (1) placing the thermometer into the water but not touching the bottom of the beaker, (2) waiting for the fluid in the thermometer to adjust, (3) aligning his eye with the fluid level in the thermometer when taking a reading, and (4) reading the temperature with the bulb of the thermometer submerged by performing those operations and reporting the temperature to within $\pm 1^{\circ}C$ of the value read by the teacher or observer.

04-Exc 8-2-1 Given the information that solutions of two chemicals are mixed, an equation showing all of the observed reactants and the solid product formed, and information that someone has predicted another product and asked to state where that product can be and how it can be recovered, the student applies the concept that unseen products are often dissolved in a solution and are recoverable by evaporating the solvent by naming the solution as containing the other product and evaporation of the solvent as the way to get the product.

04-Exc 8-3-1 Given that a specified group of atoms acts as a team, a reaction involving the team, and a list of formulas involving parts or all of the team and asked to select the formula which would be a product of the reaction, the student classifies the formula which contains the atom team intact as the only possible product of the reaction by selecting the formula containing the entire atom team.

Given a diagram of Activity 9-3 and asked why the activity must be done using distilled water first instead of putting a copper sulfate ($CuSO_4$) solution directly into the beaker, the student applies the concept that a control is used to determine if it is the variable being investigated, rather than some other variable, that is most related to the results observed by responding to the effect that it is necessary to use the distilled water first and then the $CuSO_4$ solution to show that it is the $CuSO_4$, not the water in the solution, that conducts the electricity.	05-Core-1
Given a diagram of Activity 9-3, a reminder of the conditions of that activity, and a list of four terms and asked to select the term that applies to materials or procedures used in the way that the distilled water was used in Activity 9-3, the student classifies as a control the sample which is treated in the same way as the experimental sample except for the variable being tested by selecting the term *control*.	05-Core-2
Given a diagram and a description of a situation in which the charges on the electrodes in an ionic solution are reversed and asked what effect this will have on the ion flow, the student applies the concept that ions of a given charge move toward a rod (an electrode) which is oppositely charged by responding that reversing the charges on the electrodes in an ionic solution reverses the direction that the ions flow.	05-Core-3
Given a labeled diagram of two carbon rods in a solution and asked if a certain type of ion will move towards one of the rods and to explain his answer, the student applies the concept that ions in a solution move towards an electrode if, and only if, it is charged as part of an electrical circuit by responding negatively and that there would be no motion because the electrodes were unchanged (or unconnected).	05-Core-4
Given that two objects attract each other only after they are rubbed together and three possible explanations for this and asked to select the explanation for the objects' attracting each other only after being rubbed together, the student applies the principle that some objects can be given opposite charges by rubbing them together by selecting the statement which agrees with the principle.	05-Core-5
Given an illustration and a description of a situation in which electricity is flowing through a solution, as indicated by an electric motor operating in the testing circuit, and asked to	05-Core-6

	state what kind of particles are present in the solution and to explain his answer, the student applies the concept that electricity will flow through a solution only if ions are present in the solution by responding that ions are present in the solution and with the notion of the concept.
05-Core-7	When asked to state the names of the two types of electrical charge, the student recalls positive and negative as the two types of electrical charge by stating the terms *positive* and *negative*.
05-Core-8	When asked to state the rule which describes how two objects, either of like charge or of opposite charge, will react if they are brought together, the student recalls the rule that oppositely charged objects attract and objects with like charges repel each other by responding to that effect.
05-Core-9	Given an illustrated statement that two charged objects are repelling each other and the charge on one of the objects and asked to name the charge on the other object and on what rule he bases his response, the student applies the principle that objects with like charges repel by naming the charge on the object in question and stating the notion of the rule.
05-Core-10	Given an illustration of two charged objects' attracting each other and the charge on one of them and asked to name the charge on the other, the student applies the rule that two oppositely charged objects attract each other by naming the charge opposite the known charge as the charge on the remaining object.
05-Core-11	Given a description of a situation in which charges are produced on two objects and asked how to determine whether the charges produced on the objects are the same or different, the student applies the rule that like charges repel each other and unlike charges attract each other by responding that the two objects should be put near one another to see if they attract or repel or that the two objects should be brought near a single charged object to see if they react the same or differently.
05-Core-12	Given a description of a situation in which electrodes are placed in a solution containing ions of a given charge and asked if those ions will move towards or away from an electrode of the opposite charge and to state why, the student applies the concept that opposite charges attract by stating that the ions will move toward the oppositely charged rod and the notion of the rule.

Given three solutions and told to get any materials he needs to determine which, if any, of the three solutions contains the sulfate ion (SO_4), the student applies the rule that the presence of the SO_4 ion is shown by a cloudy white solid formed when barium chloride ($BaCl_2$) is added to a solution in which the SO_4 ion is present by adding $BaCl_2$ solution to the solutions and reporting that the SO_4 ion is present in those solutions in which a white solid forms. 05-Core-13

When asked why operational definitions are important, the student applies the concept that an operational definition states the way in which we can determine the presence or absence of a substance by responding to that effect. 05-Core-14

Given the formula for a multi-atomed ion and asked if the ion contains just one element and either to identify the one element or to tell how many elements are present in the ion, the student applies the convention that each different symbol in a formula indicates a different element by responding negatively and stating the number of elements indicated by the formula. 05-Core-15

Given two compounds and asked to identify the force that holds them together according to the model for matter being developed in the ISCS course, the student applies the concept that matter is held together by electrical force by stating the concept. 05-Core-16

Given a list of three different positive ions and three different negative ions and asked to predict three pairs of ions which would combine to form compounds, the student applies the concept that opposite charges attract and like charges repel by predicting combinations of only positive and negative ions. 05-Core-17

Given illustrations of pairs of ions charged as follows: + +, - -, + -, and - +, and asked to select those pairs that will attract each other and why he selected them, the student applies the concept that unlike charges attract by selecting only those pairs with unlike charges and stating the concept. 05-Core-18

Given that there are two particles in a specified compound and told the kind of charge on one of them and asked what the kind of charge is on the other and to state the basis for his prediction, the student applies the concept that oppositely charged particles of matter attract each other by naming the charge opposite to the charge given and stating the rule. 05-Core-19

05-Core-20	Given four possible reasons for labeling materials and recording observations and asked why the text continually states that he should label his materials and record his observations, the student classifies labeling materials and recording observations as helpful investigatory procedures by selecting the entry to that effect.
05-Core-21	Given two quotations about the atomic model from two science textbooks, one dogmatic and the other tentative, and five statements about the quotations and asked to select the statement that includes both which quotation a scientist would prefer and why, the student applies the concept that scientists consider their models and the explanations based on them to be tentative by selecting the statement about the quotation which is written in tentative terms and which includes the notion of the concept.
05-Core-22	Given four possible criteria for the acceptance of a statement by scientists and asked to select the criterion for acceptance of a statement used by scientists, the student applies the concept that scientists accept statements when they are based on experimental evidence by selecting the phrase which illustrates the concept.
05-Core-23	Given four statements about ions and asked to select the statement which best describes why ions are presented in Chapter 10, the student applies the concepts that ions are part of a model and are useful in explaining certain observations, rather than that ions are known to exist in matter by selecting the entry stating the usefulness of the model in explaining certain phenomena.
05-Exc 9-1-1	Given a metaphorical story about riding the "Ion Express" and asked to name what the rider (a particle) would have to be charged to ride toward a town (a rod) with a specified charge, the student applies the concept that oppositely charged objects attract each other by responding with the charge opposite that of the specified charge on the rod.
05-Exc 10-1-1	Given diagrams of two sets of crystals resulting from the evaporation of samples of the same solution, each set of crystals having the same shape and color but differing greatly in size, and asked which sample evaporated faster and to explain his answer, the student applies the concept that the rate of evaporation is inversely related to crystal size by naming the sample with the smaller crystals and stating that rapid evaporation produces smaller crystals than slower evaporation.

Given an open textbook and the data for Table 1 on page 472 of his text and a statement that the data was collected working with the equipment shown on page 473 but using a different metal and solution and asked to give and diagram an explanation of the given data, the student applies the concept that particles move from one electrode to another as electricity flows through the conducting solution by stating and diagraming the essence of the following two statements: (1) some of the atoms (or ions) of metal in the positive strip separated and disappeared into the solution and (2) these ions (and perhaps some of the ions already in the solution) moved to the negative strip and collected there, forming whiskers.

05-Exc 10-2-1

Reminded that used solutions are put into waste jars and not back into the reagent jars, even when no other chemicals have been added to them, and asked to explain why, the student applies the rule that reagents are never put back into reagent bottles because they might be contaminated or be put into the wrong bottle and contaminate it by stating that notion.	06-Core-1
Given that the particles of an element in a solution are not attracted to either electrode and options involving the terms *ions* and *atoms* and asked to identify the kind of particles in the solution, the student classifies the particles of an element in a solution which are not attracted to either electrode as atoms by selecting the term *atoms*.	06-Core-2
Given the charge on an electrode and that a specified ion is moving toward it and asked the charge on the ion, the student applies the concept that an ion moves toward an electrode whose charge is opposite to that of the charge on the ion by stating the charge on the ion.	06-Core-3
Given a description of a situation in which two neutral objects are charged by being rubbed together and asked to explain how the rubbing produces the charges, the student applies the concept that neutral objects can either gain or lose charges (negative) when rubbed, thus leaving the objects charged by responding with the notion of the concept.	06-Core-4
Given a description of a situation in which rubbing objects A and B together produces a charge on both of the objects and asked to predict whether the objects will attract or repel each other and to explain, the student applies the rules that if charges are produced on objects which are rubbed together, they are oppositely charged and that like charges repel and unlike charges attract each other by responding that rubbing the two objects together produces opposite charges on them which causes them to attract each other.	06-Core-5
Given two cases, one in which material X has a positive charge and one in which material Y has a negative charge, and in each case four statements purporting to describe the charged material and asked in each case to select the statement that best describes the charged object, the student classifies a positively or negatively charged object as having an excess of positive or negative charge respectively by selecting the description that agrees with that notion in each case.	06-Core-6

06-Core-7	Given a description of a situation in which two neutral objects are given opposite charges by rubbing them together and asked to explain how opposite charges are produced, the student applies the concepts that neutral objects have equal numbers of positive and negative charges and that when they are rubbed together, they become oppositely charged because negative charges are removed from the surface of one, leaving that object positive, and adhere to the surface of the other, making it negative, by responding with the notion of those concepts.
06-Core-8	Given four phrases stating relative amounts of positive and negative charges and asked which phrase describes the relationship between the numbers of positive and negative charges in neutral objects, the student classifies objects having equal numbers of positive and negative charges as neutral objects by selecting the statement to that effect.
06-Core-9	Given a description of a situation in which object X is attracted to two oppositely charged objects and asked what the charge on object X is, the student applies the concept that a neutral object is attracted to objects with either a positive or a negative charge by stating that the charge on object X is neutral.
06-Core-10	Given that a neutral object and a charged object are brought into contact with each other and that they first attract, then repel, and continue to repel each other and asked to explain these observations, the student generates an explanation for the actions of the charged and neutral objects brought into contact with each other by responding to the effect that the neutral object has equal numbers of positive and negative charges and that at first the charged object attracts the opposite charges on the neutral object; thus, one side of each object is attracted to the other object, and when they come together, the excess charge of the charged object is split with the neutral object and the neutral object becomes similarly charged, after which they have like charges and repel each other.
06-Core-11	When asked to give an operational definition for *neutrally charged particle of powder*, the student generates the operational definition that a neutrally charged particle of powder is a particle which is attracted both to positively and to negatively charged objects by stating the notion of the definition.
06-Core-12	Given a list of five properties of substances and asked to select those he will need to know if he is to determine whether a specified substance is made up of ions, of one kind of atom, or

of one kind of molecule, the student classifies the property of conductivity of a solution of the substance and the property of decomposability of the substance as the two properties by which he can identify the kind of particles in the substance by selecting those two properties.

Given four entries -- smaller molecules, atoms, elements, and other compounds -- and the option "all of these" and a description of a situation in which large molecules are broken down and asked to select possible products of the breakdown of a large molecule, the student classifies smaller molecules, atoms, elements, and other compounds as possible breakdown products of a large molecule by selecting the option "all of these." 06-Core-13

Given a description of a situation in which the dry powder of a substance is attracted to each of two oppositely charged objects and asked if he agrees or disagrees with the conclusion that the substance is therefore made up of molecules and to explain his answer, the student applies the concept that the attraction of the particles of a substance to charged objects is irrelevant to its being ionic or molecular by responding that he disagrees with the conclusion and with the notion of the concept. 06-Core-14

Given an example of a molecular substance and asked what force holds the neutral atoms in the neutral molecule together and how this force exists in a neutral molecule, the student applies the concepts that all matter contains positive and negative charges and that it is the attraction of these different charges which holds neutral atoms in a molecule together by responding with the term *electrical force* and with the essence of those concepts. 06-Core-15

Given the name of a substance and told that it is made up of atoms of more than one kind combined in definite numbers (ratios) and asked what kind of matter it is, the student classifies a substance which is composed of atoms of more than one kind combined in definite numbers (ratios) as a compound by responding with the term *compound*. 06-Core-16

Given a description of a situation in which an atom has gained or lost a negative charge, thereby becoming a charged particle, and asked to name the charged particle, the student classifies an atom which has gained or lost a negative charge, thereby becoming a charged particle, as an ion by responding with the term *ion*. 06-Core-17

Given five statements about the possible makeup of a substance and told that the substance is molecular and asked to select those 06-Core-18

	statements which are true about the substance, the student classifies as the properties of a molecular substance that (1) it contains positive and negative charges, (2) its solution will not conduct electricity, (3) it doesn't contain ions, (4) it would be attracted to either a positively or a negatively electrostatically charged strip, and (5) it is a neutral particle by selecting all statements which agree with those.
06-Core-19	Given four statements, including the statement that matter contains movable negative charges, and asked to select the statement which is part of the atomic model, the student classifies the statement that matter contains movable negative charges as the only statement in the list that fits the atomic model by selecting only the statement to that effect.
06-Core-20	Given a statement to the effect that he is developing a model of his own which is moving toward the same model for matter already developed and completed by scientists and asked if he agrees or disagrees with this statement and why, the student applies the concept that the models of science are under continuous development and refinement and are never complete by responding to that effect.
06-Core-21	Given five possible interpretations of acceptance of a model by scientists and asked to select the best interpretation, the student applies the concept that acceptance of a model implies only that it explains observations made to date by selecting the entry involving the explanation of observations.
06-Core-22	Given a construct central to a scientific model and four statements about models and their constructs and asked to select the criterion by which models are judged, the student applies the concept that models and their constructs are accepted as useful ways of thinking about phenomena by selecting the response to that effect.
06-Core-23	Given the four terms *atoms*, *molecules*, *neutral particles*, and *ions* and asked when one is considering electrical charges, which of those terms doesn't belong in the same group with the other three, the student classifies atoms, molecules, and neutral particles as having no charge (equal numbers of positive and negative charges) and ions as having a charge by selecting the term *ion*.
06-Core-24	Given five entries from the following list of properties of atoms and ions: (1) [ions] can be particles with an excess of negative charges, (2) [ions] in solution are attracted to a rod with a

charge, (3) [atoms] are present in a piece of a specified element, (4) [ions] are responsible for conducting current in a solution, (5) [atoms] have equal numbers of positive and negative charges, (6) [ions and atoms] contain positive and negative charges, (7) [ions and atoms] can be colored, and (8) [ions] can be particles with more positive charges than negative, and asked to identify which statements are true of atoms, which of ions, and which of both, the student classifies entries as the properties of atoms, of ions, or of both by labeling the given statements correctly in four of the five cases.

Given that each of three substances is attracted both to positively and to negatively charged strips, that all of them in solution conduct electricity, and four statements, each attributing either ionic or molecular makeup to the substances and each making a statement about a ratio of positive and negative charges in the substances, and asked to select the descriptive statement justified by the data, the student classifies the substances which are attracted both to positively and negatively charged strips and whose solutions conduct electricity as being ionic and having an equal number of positive and negative charges by selecting the statement of those characteristics. 06-Core-25

Reminded that for many years people considered water to be an element and asked if it is and to explain his answer, the student classifies water as not being an element because it can be broken down into two different substances (atoms) by stating that it is not an element and the notion of the concept. 06-Exc 11-1-1

Given that a student found that a stream of drips was attracted to a charged strip and that he therefore concluded that the drips were neutral and asked if this is a good conclusion and to explain his answer, the student applies the concept that objects with opposite charge, as well as neutral charge, would be attracted to a charged strip by stating that the conclusion is a poor one and the notion of the concept. 06-Exc 11-2-1

Given five graphs of brightness plotted against grams of salt and asked to look at Excursion 11-3 and to determine which of the graphs is the general shape of the graph of his data in the excursion, the student classifies the graph showing a steep rise in brightness for small increases in grams of salt and then a sudden change to an almost horizontal line as the graph which represents his data for the excursion by selecting such a graph. 06-Exc 11-3-1

06-Exc 12-1-1	Given the combining power of two different atoms, a specific number of each of the two kinds of atoms, and a series of diagrams showing possible combinations of these atoms, the student applies the concept that atoms combine according to their particular combining powers by selecting the sketch which shows the atoms combined in accordance with their combining powers.
06-Exc 12-1-2	Given the structural formula of a molecule and asked to draw an isomer of that molecule, the student applies the concept that an isomer of a molecule contains the same number and kind of atoms arranged according to the combining power of each atom by drawing a structural formula which shows a different arrangement of the atoms (not simply changed by bending) and maintains the number and kinds of atoms and the combining powers of the atoms in the given formula.
06-Exc 12-1-3	Given that each of two students has a chemical substance, that each student gives a chemical formula for his substance which is the same as that given by the other student, and test results for each substance, showing that they have different physical properties, and asked if it is possible that both students really have compounds with the same formula and to explain his answer, the student applies the concept that molecules with the same number and kind of atoms which differ only in the arrangement of those atoms will have different properties by responding affirmatively and explaining in effect that some compounds (isomers) have the same formula, but different properties, because their atoms are arranged differently.

Given a sentence using the term *reaction rate* and asked to define *reaction rate* as used therein, the student recalls the definition that reaction rate is the speed at which a reaction takes place by responding to that effect.	07-Core-1
Given the name of a common solution and a list of five variables relating to the solution and asked which of those variables must be known to state the concentration of the solution, the student classifies the mass of the dissolved substance and the volume of the solution as the variables involved in determining the concentration of a solution by selecting those variables.	07-Core-2
Given a sentence using the word *concentration* in a chemical context and asked to define the term *concentration* as used in the sentence, the student recalls the definition that the concentration of a solution is the amount of dissolved substance in a definite amount of a solution or liquid (solvent) by responding to that effect.	07-Core-3
Given a list of five observations, including three which are indicators of reaction rate, and asked to select the observations which are indicators of reaction rate, the student classifies as indicators of the reaction rate (1) the amount of product formed per time period, (2) the speed at which the reactants are used up, (3) the temperature change per time unit, and (4) the time required for the first noticeable changes by selecting at least two of the three of the above which appear as options.	07-Core-4
Given a diagram and a description of a situation in which two equal samples of the same solution are equally diluted and asked to compare the final concentrations of the solutions and to explain his answer, the student applies the principle that if equal samples of a solution are equally diluted, the resulting concentrations of the resulting solutions are equal by stating that the concentrations are equal and the effect of the rule.	07-Core-5
Given a data table which describes equal volumes of a given solution in five different dilutions, including a zero dilution, and asked to order the solutions from the most to the least concentrated, the student classifies the solutions according to their concentrations from the most to the least concentrated by ordering them in increasing order of the amount of solvent added.	07-Core-6
Given graphs of the volume of gas produced versus time for two reactions involving the addition of unknown amounts of reactant A	07-Core-7

	to equal amounts of reactant B and asked in which situation the greater amount of reactant A is used and to explain his answer, the student applies the rule that as long as enough of both reactants are available, the rate of product formation is proportional to the amounts of the reactants used by selecting the graph which indicates the greater volume of gas produced and stating the essence of the rule.
07-Core-8	Given descriptions of two trials of the same reaction, each trial using a different concentration of one of the reactants, and asked if the reaction rates of both trials would be the same and to state the variable that accounts for his answer, the student applies the concept that a change in the concentration of the reactants causes a change in the reaction rate by stating that the reaction rates of the trials would be different and that the variable is *concentration*.
07-Core-9	Given a description of two trials of the same reaction, using different concentrations of one of the reactants, and asked if the reaction rates of both trials would be the same and to explain his answer in terms of particle collisions, the student applies the concept that a change in the amount and the concentration of a reactant causes a change in the reaction rate because these changes increase the number of contacts between particles of the reactants by responding negatively and stating the essence of the concept.
07-Core-10	Given diagrams of two beakers, each containing a different concentration of a dissolved reactant, and of a fixed amount of a second reactant to be added to each and told that the reaction rates will be different in each beaker and asked to explain how the particle model would explain this, the student applies the concept that if more particles of a reactant are present in one reaction than the other, the reacting particles in the first reaction will collide more frequently and react more often than those in the second by stating the essence of the concept.
07-Core-11	Given the relative speeds of solid, liquid, and gaseous particles and three reactions which have one constant reactant (A), and a second reactant (B) which varies in each reaction -- one a solid, one a liquid, and one a gas -- and asked which of the reactions would have the fastest reaction rate and to explain his answer in terms of the particle model, the student generates the statement that the reaction in which B is gaseous is fastest because gaseous particles move faster than solid or liquid particles and therefore the most particle contact results by selecting the reaction in which B is a gas and stating in effect the reasoning above.

Given the following variables -- number of particles, volume, kinetic energy, particle speed, particle size, and collision rate -- and asked if these increase, decrease, or remain the same when a substance is heated, the student classifies volume, kinetic energy, speed, and collision rates as increasing and the others as remaining the same by so indicating. 07-Core-12

Given two trials of a reaction, both involving identical amounts of the same reactants but at different temperatures, and the trial with the higher reaction rate having a faster reaction rate and asked how the particle model explains this, the student applies the concept from the heat-as-energy model that at higher temperatures matter particles move faster, collide more frequently, and therefore react more rapidly by stating the essence of that concept. 07-Core-13

Given two reactions in which the amounts of the reactants are the same but the reaction rates are different and the temperature of only one of the reactions is known and asked what and how he can tell about the temperature of the other reaction, the student applies the concept that the rate of a reaction varies with its temperature by stating that the unknown temperature is higher than the known temperature if the rate of the reaction whose temperature is unknown is faster or the reverse if the related reaction rate is slower than the reaction rate of known temperature. 07-Core-14

Given a graph of the increase in reaction rate versus temperature and a series of equal temperature intervals and asked in which of the temperature intervals there is the greatest change in reaction rate, the student applies the process of reading and analyzing a curved-line graph by indicating the interval of highest temperatures as producing the greatest change in the rate of reaction. 07-Core-15

Given data for two trials of a chemical reaction, neither of which involves a catalyst and all the reactants of which are in the liquid state, but in which one trial has a higher concentration and lower temperature than the other, and the information that they have the same reaction rates and asked if the collision rates are the same and how he would explain his answer in terms of the particle model, the student applies the concept that many particles moving slowly can have as many collisions as fewer particles moving more rapidly by responding affirmatively and stating the effect of the rule. 07-Core-16

When asked to give the definition for *catalyst*, the student recalls the definition that a catalyst is a substance which 07-Core-17

increases the rate of a reaction, but does not cause the reaction nor act as a reactant, by stating a definition to that effect.

07-Core-18 Given three pairs of descriptions of chemical reactions, each pair made up of a reaction with and a reaction without an additive, and asked for each pair if the additive is a catalyst, the student classifies as a catalyst any additive which causes an increase in the speed of the reaction but does not react itself or cause the reaction by so indicating.

07-Core-19 Given a reaction and a means by which its reaction rate could be determined and asked to design a procedure to determine if a given substance is a catalyst for the reaction and to state those variables which must be held constant and those which would be varied, the student applies the concepts that only one variable should be varied (using or withholding the substance being used as a catalyst), that all other variables (temperature, concentration or amounts of reactants used, and the method of measuring reaction rates) should be held constant, and that a catalyst does not react or cause the reaction by stating a design which includes those concepts.

07-Core-20 Given the name of a substance postulated as a catalyst for a reaction and that increasing and proportionately larger amounts of the substance are added to different trials of the reaction and asked if trials using even greater amounts of the substance need to be made to determine if the substance could indeed be a catalyst for the reaction, the student applies the concept that only small amounts of a catalyst are needed to cause an increase in the rate of a reaction by responding negatively and that if the substance were a catalyst, small amounts of it would have affected the reaction rate.

07-Core-21 Given a reaction and several substances claimed to be catalysts for the reaction and asked how many of these claims could be correct and why, the student applies the concept that there is often more than one catalyst for a reaction by responding that all of them could be catalysts and the essence of the concept.

07-Core-22 Given the information that a reaction rate is often affected by temperature, concentration, and a catalyst, a statement of a reaction, and an indicator for the occurrence of the reaction and asked to state a method by which he could determine that changes in the concentration of a reactant alter the reaction rate and to state which things should be held constant and which should vary, the student applies the procedures to show whether concentration affects the rate of a reaction and of measuring reaction rate in

terms of the rate of product formation by stating a procedure which (1) varies the concentration of the single reactant being studied, (2) keeps the concentrations of other reactants constant, (3) keeps the temperatures of the reactants constant, (4) does not alter the use or nonuse of a catalyst, and (5) records the interval between the time the chemicals are mixed and the time the indicator begins to work.

Given that a substance is a catalyst for a reaction and the conclusion that it therefore must be a catalyst for a different reaction and asked if he agrees and to explain his answer, the student applies the concept that a substance is a catalyst to a specific reaction and not necessarily to others by responding negatively and with the effect of the rule. 07-Core-23

Given a list of five alternatives, two of which are variables that can affect the reaction rate, and asked to select the variables that affect the reaction rate of a chemical reaction, the student classifies (1) the temperature of reactants, (2) the concentration of reactants, and (3) the presence of a catalyst as the variables that affect the rate of a chemical reaction by selecting whichever two of the variables listed above appear as options. 07-Core-24

Given the choices of high, medium, or low for concentrations and temperatures and the choices of present or absent for a catalyst and asked to identify the combination of temperature, concentration, and catalyst which would result in the fastest reaction rate, the student classifies the combination of high concentration, high temperature, and the presence of a catalyst as the combination that results in the fastest reaction rate by selecting that combination. 07-Core-25

Given a graph of reaction time versus concentration and asked in which trial the number of collisions between reacting particles is the greatest per second and to explain his answer, the student applies the concept that the greater the concentration of particles, the greater the number of collisions and the shorter the reaction time of the substance by selecting the trial with the shortest reaction time and by stating the effect of the concept. 07-Exc 13-1-1

Given a reaction and four graphs and asked which of the graphs correctly shows the relationship between concentration and reaction time, the student identifies the graph showing a concave curved line which slopes downward from left to right as a graph of reaction time versus concentration by selecting that graph. 07-Exc 13-1-2

07-Exc 13-2-1	Given two cases, one in which a compact form of a substance will not burn even at high temperatures and one in which the dust of the substance burns explosively at low temperatures, and asked how this can be explained, the student applies the concepts that increasing the surface area of a reactant speeds up the rate of the reaction and that in the dust form, the reactant has more surface area than in the compact state by stating the essence of those concepts.
07-Exc 14-1-1	Reminded that reactions involving air take place more slowly in cold air than in warm air and asked how the particle model would explain this, the student applies the concept that in cool materials, particles move more slowly and collide less often, and therefore the reaction rate is slowed down by stating such an explanation.
07-Exc 15-1-1	Given that vegetables are cooked slightly, but not completely, before they are frozen in order to retard spoilage and asked why this is done, the student applies the concept that heating destroys the catalysts which hasten spoilage in living things by responding to that effect.
07-Exc 15-1-2	Given that a specific reaction takes place at a much lower temperature in his body than outside of his body and asked to explain why, the student applies the concepts that he, like all living things, contains catalysts and that catalysts allow rapid reaction rates at lower temperatures than otherwise possible by responding with the effect of those concepts.

Given a reaction from Chapter 16 and asked what effect increasing the concentration of one of the reactants would have on the reaction, the student applies the concept that increasing the concentration of a reactant increases the rate of reaction by so responding. 08-Core-1

Given a statement of the reaction of Activity 16-11 and that ammonia (NH_3) would be given off without heating and asked why he heats the mixture, the student applies the concept that heating increases the speed of the reaction by responding to that effect. 08-Core-2

Given two solutions, A and B, and asked if the addition of solution B to A changes the odor of A, the student manipulates solution A to smell it safely by gently waving his hand back and forth over it, rather than putting the bottle or beaker near his nose and inhaling. 08-Core-3

Given that four substances from Table 16-2 are all composed of N, C, H, and O and yet are so different and asked to explain, the student applies the concept that different substances can be composed of the same elements put together in different orders or combinations by stating that notion. 08-Core-4

Given a list of five substances and a statement about their ammonia, sulfate, and copper content in each case and asked to select the cases in which he can be absolutely sure nitrogen is present, the student classifies all the cases in which ammonia is present as those containing nitrogen by selecting those and only those. 08-Core-5

Given that two substances containing nitrogen each give negative results in tests for ammonia (NH_3) and the conclusion that therefore these substances do not contain nitrogen and asked if he agrees with the conclusion and to explain his answer, the student generates an explanation that because Nesslers's solution is a test for NH_3, nitrogen in any other combination would not be detected by it by responding that he disagrees and with the effect of the aforementioned explanation. 08-Core-6

Given a substance and asked to carry out a stated procedure to show whether or not the substance contains ammonia and to state his conclusions, the student manipulates the materials to test a substance for ammonia by adding NaOH and boiling chips to the sample, heating it, passing the gas through a mixture of Nesslers's 08-Core-7

solution and NaOH, and correctly stating that ammonia is present if the Nesslers's solution changes to an orange-yellow color.

08-Core-8 Given two solutions, A and B, and asked if the addition of solution B to solution A changes the odor of A, the student chooses to use safety glasses to protect his eyes by putting on a pair of safety glasses before beginning the procedure.

08-Core-9 Given a reminder of the acceptance of the concept that combinations of relatively few elements account for all known substances and asked to explain why scientists reinvestigate accepted ideas, using different sets of materials, the student applies the concept that scientific concepts are tentative — that is, supported by evidence, but not proven to be true -- and they could be changed if not supported by further investigations by stating the general notion of the concept.

08-Core-10 Given the name of a chemical indicator used in ISCS Level II to indicate the end point of a reaction and asked to tell how it works and why it works when it does, the student generates the explanation that a substance which is an indicator changes color as the result of a chemical reaction with one of the reactants after all of the other reactant is used up by responding to that effect.

08-Core-11 Given that a prediction has been made of what volume of a reactant is needed to react with a named amount of a second reactant, based on a trial of the reaction using other amounts of the second reactant, and asked on what basis such a prediction can be made, the student applies the concept that when atoms of substances react, they do so in definite numbers (ratios) by responding to that effect.

08-Core-12 Reminded of the procedure used in Activity 17-3 and asked to explain why doing the procedure twice and finding an average is better than just doing it once, the student applies the concept that averaging repeated measurements is a way of decreasing the effect of individual experimental errors by responding to that effect.

08-Core-13 Given a reaction and a graph of the amounts of the two reactants that reacted in three trials of the reaction and asked to state how much of one of the reactants would react with a stated amount, beyond the plotted data, of the other reactant, the student applies the procedure of extending the curve of a graph and read-

ing the value of the unknown coordinate corresponding to the value of the known coordinate by stating a value which is within ±0.5 gram of the value read by the teacher.

Given a reaction and a graph of the amounts of two of the reactants that reacted in three trials of the reaction and asked to state how much of one of the reactants would react with a specific amount of the other, which reaction is beyond the plotted data, and to select the reason why he can make such a prediction, the student applies the procedure of extrapolating the graph value of the unknown amount of one reactant corresponding to the value of the known amount of another reactant and the concept that when two reactants combine, they do so in definite numbers by stating the value of the unknown coordinate and selecting an option to the effect of the concept. 08-Core-14

Given directions to (1) dissolve a given amount of a solid in 15 ml of water, (2) add 2 drops of Congo red, (3) add acid in small quantities until a permanent color change is observed, (4) find the amount of acid neutralized, and (5) repeat steps 1 through 4 and average the two trials and asked to use the procedure to titrate a particular solution, the student manipulates the materials and equipment according to the procedure outlined by reporting an average result of the neutralization of within ±2 ml of the value obtained by the teacher. 08-Core-15

Given that the mass and the volume of a substance are increased by the addition of more of the substance and asked what effect this addition has on the density of the substance and why, the student applies the concept that the density of a substance is independent of the amount of the substance present by responding that the density is unaltered and with the effect of the concept. 08-Exc 16-1-1

Given a solution of water and food coloring and asked to measure out a specific volume, to find its density, and to show his work, the student applies the concept that the density of a material is equal to its mass divided by its volume by measuring the volume and mass of the solution and calculating its density and by reporting it to within ±0.25 g/ml. 08-Exc 16-1-2

Given a list showing the density of four solids and the name of a liquid whose density is specified and asked whether the solids would float or sink in the liquid, the student applies the concepts that substances with densities greater than that of the liquid will sink and that substances with densities less than that of the liquid will float by selecting the objects that will sink and the objects that will float. 08-Exc 16-1-3

08-Exc 17-1-1	Given a reminder of Activities 17-5 and 17-6 and asked if the use of a specified amount of water other than 10 ml would affect the amount of stomach acid neutralized by the antacid and to explain his answer, the student applies the concept that it is the quantity of a reagent present, and not its concentration, that determines the quantity of other reagents it reacts with by responding negatively and that the quantity of reagent is unchanged.
08-Exc 17-2-1	Given that as reagent A is added to reagent B, the reaction proceeds vigorously and then stops, even when further amounts of A are added, and asked to explain, the student applies the concept that a given amount of a reagent will react with a definite amount and no more of another reagent by so stating.
08-Exc 17-3-1	Given litmus paper and three liquids -- an acid, a base, and neutral water -- and asked to indicate whether the substances are acids, bases, or neither, the student manipulates the materials and tests drops of the solutions on litmus paper to determine if they are acids, bases, or neither by labeling the solution which turns red litmus to blue as a base, the one which turns blue litmus to red as an acid, and the one which produces no change as neither.
08-Exc 17-3-2	Given the pH of five acid solutions and asked which of the acids contains the most H^+ ions, the student applies the concept that pH and H^+ ion concentrations vary inversely and the stronger the acid the greater the H^+ ion concentration by selecting the solution with the lowest pH as having the highest H^+ ion concentration and as being the strongest acid.
08-Exc 17-3-3	Given pH paper, a pH color scale, two acids, two bases, and water and asked which is the strongest acid and which is the strongest base, the student manipulates the solutions, the pH paper, and the pH scale to determine the strengths of acid and base solutions by placing drops of the solutions on the paper and comparing the resulting color spots with the color scale for the paper and reporting the solution whose spot is nearest to the red as most acid and the solution nearest to the blue as most basic.

Given a diagram of an object and a metric ruler and asked to measure its length in centimeters, the student manipulates the metric ruler to measure the length of the object by reporting its length to within ±0.1 cm of the given answer. 09-Core-1

Given two different metal strips, a solution, a beaker, two test leads, and a voltmeter and asked to assemble them as a chemical system which might produce electricity (a battery) and to find out if his system does indeed produce electricity and how he knows, the student manipulates these materials to set up a chemical system as a battery and to determine if the system produces electricity by setting up the apparatus as shown in Activity 18-6 and responding affirmatively and to the effect that the movement of the needle of the voltmeter is evidence of the flow of electricity. 09-Core-2

Given a list of five forms of energy and asked to select the form in which energy is stored in a battery, the student recalls that electrical energy is stored in a battery as chemical energy by selecting the term *chemical*. 09-Core-3

Given a diagram and a description of an observation of a chemical reaction which occurs in a system when the system is connected to a battery charger and asked what kind of change occurs and its cause, the student classifies a change in the color and the formation of a solid from a solution onto electrodes (electroplating) as a chemical change and electrical energy as its cause by stating that the change is a chemical change and electrical energy is its cause. 09-Core-4

Given descriptions of the differences in appearance of two reactants and of the products of a reaction and asked if new atoms are formed in the reaction, to name them if they are, and if not, to explain how it happens that products so different from the reactants are formed, the student applies the concept that in a chemical reaction the atoms of the reactants are simply recombined to form the products by responding negatively and with the essence of the rule. 09-Core-5

Given a diagram of a chemical system and asked to list observable things which would indicate that a change in the chemical energy of the system has occurred, the student applies the concept of the operational definition of a chemical reaction and the rule that the chemical energy of a chemical system can be changed only if the system undergoes a chemical reaction by listing at least three 09-Core-6

	of the following: (1) a new solid is produced, (2) a gas is produced, (3) the temperature changes, (4) the color changes, and (5) a flow of electricity is produced.
09-Core-7	Given a diagram and a description of a chemical system which is producing electricity and asked what is happening to the chemical energy of the system and if any energy was lost or gained and to explain his response, the student applies the concepts that energy can be neither created nor destroyed, but can be converted from one form into another, by responding that the chemical energy of the system decreased or that it is converted into electrical energy, and the essence of the concepts.
09-Core-8	Given observations of reactions that occur in a chemical system which is being charged and asked to describe the changes which occur in the system as it is discharged, the student applies the concept that the discharging reactions in a rechargeable battery are the reverse of the charging reactions by describing changes which are the reverse of those which take place during charging.
09-Core-9	Given that a battery is rechargeable and asked to name the process which describes the changes involving the particles inside a battery when it is being charged or discharged, the student applies the concept that a chemical reaction occurs both when a battery is being charged and when it discharges by responding to that effect.
09-Core-10	Given a description of two chemical systems set up as batteries, one of which undergoes changes which indicate a chemical reaction and one of which does not, and asked which system is more likely to have produced electricity and to explain his answer, the student applies the concept that if electricity is produced by a chemical system (a battery), a chemical reaction occurs and if no reaction occurs, then no electricity is produced, by stating that the system in which the changes occur would be more likely to have produced electricity and the essence of the concept.
09-Core-11	Given a description of a situation in which a battery is recharged and asked the kind of energy that is used to charge the battery, that is present in the battery after charging, and that is released from the battery, the student classifies the form of energy used to charge a battery as electrical, the form of energy in a charged battery as chemical, and the form of energy released from it as electrical by so responding.

Given that a chemical system produces electricity over a period of time and the statement that the components of the system remain unchanged and asked if the statement is true and to explain his answer, the student applies the rule that a chemical reaction takes place if electrical energy is released from the chemical system by responding negatively and with the effect of the rule.	09-Core-12
Given examples of things which in general or scientific terms are considered to be work and asked which of the examples fit the operational definition of *work*, the student classifies examples in which a force is applied over a distance as involving *work* as defined scientifically by selecting only such examples.	09-Core-13
Given that it takes more energy to charge a battery than the battery will produce when it discharges and asked whether the missing energy was destroyed or used up and to explain the student applies the concepts that energy is not destroyed in an energy conversion, but that it is changed into another form, by responding negatively and to the effect of the concepts.	09-Core-14
Given an equation for a reaction and the fact that energy is released by the reaction and asked which has the greater chemical energy, the reactants or the products, and to explain his answer, the student applies the concepts that energy can be neither created nor destroyed and that one form of energy is only converted to another form by selecting the phrase which indicates that the chemical energy of the reactants is greater than that of the products and explaining the essence of the concepts.	09-Core-15
Given that when a solid is dissolved in a liquid, the temperature of the liquid drops, and five choices as to what happens to the energy and asked to select the option which tells what happens to the energy in the system, the student applies the concept that in ordinary reactions, energy is neither created nor destroyed, but can only be changed in form, by selecting only the option to the effect that the energy changes form.	09-Core-16
Given a statement that one substance has been dissolved in another in an insulated Styrofoam cup and asked whether the amount of energy present before dissolving is less than, equal to, or greater than the energy present after dissolving, the student applies the concept that energy can be changed from one form into another by selecting the option which indicates that there is no change in the amount of energy present.	09-Core-17

09-Core-18	Given the direction to add water to anhydrous copper sulfate ($CuSO_4$) while touching the container and asked if a chemical reaction occurs, whether the particles combine or separate, and how he can tell, the student applies the concepts that when two substances are mixed and a color change is observed, a reaction has occurred and that a rise in temperature indicates a combining of particles by responding that a reaction occurred, that the particles combined, and that he knows because the temperature increased.
09-Core-19	Given that two solutions at the same temperature are mixed and that a temperature increase results and asked to use the particle model to explain the temperature change, the student classifies the combining of particles as releasing energy by stating that the combining of particles to form the solid is the cause of the temperature change.
09-Core-20	Given that the temperature of water drops when a specified solid is dissolved in it and asked what, according to the particle model, causes a temperature drop to occur, the student applies the concept that when a solid dissolves, energy is needed to overcome the electrical attraction between the particles in the solid by stating the effect of the concept.
09-Core-21	Given a list of two physical changes, one chemical change, an "all of these" option, and a "none of these" option and asked how the chemical energy of a fixed mass of a substance can be converted into another form of energy, the student applies the concept that the chemical energy of a compound is converted into another form of energy by a chemical reaction in which it is converted into a different substance by selecting the option which designates a chemical reaction.
09-Core-22	Given that a specific compound has a great deal of chemical energy and asked what causes any compound to release its chemical energy, the student applies the concept that the amount of chemical energy in a particular mass of matter can be changed during a chemical reaction by responding to that effect.
09-Core-23	When warned to assume that each of two jars contains a dangerous chemical, namely Winkler's solution and concentrated sulfuric acid, and asked to collect the materials necessary to mix a certain amount of one into the other, the student chooses to use safety glasses to protect his eyes while mixing the chemicals by putting on the safety glasses before mixing the two chemicals.

Given the warning that Winkler's solution and concentrated sulfuric acid are two dangerous chemicals that he will be using in the next chapter and asked to state three things he should do if one of these solutions is spilled on him or on a classmate, the student recalls that when an unknown or a dangerous chemical has been spilled on a person, the procedure is (1) to rinse the area with plenty of water, (2) to call the teacher, and (3) if possible, to show or tell him what the chemical was by stating at least two of the three procedures. 09-Core-24

Reminded of the procedure used in Excursion 18-1 and asked why after the chemical system had been assembled it would not light the bulbs until it had first been charged, the student applies the concept that energy must be put into a system before energy can be obtained from the system by responding to that effect. 09-Exc 18-1-1

When asked to determine where the zinc goes in a chemical system composed of a zinc strip, a carbon rod, and a $K_2Cr_2O_7$ solution in a beaker, the student generates a procedure for identifying what becomes of the zinc which disappears from the zinc strip in a chemical cell and modifies or defends the steps of his model to meet his instructor's objections by independently designing a procedure in Excursion 18-2 and defending or modifying it. 09-Exc 18-2-1

Given a list of six energy conversions and asked to give an example of any four of the specified energy conversions, the student applies the concept that energy can be converted from one form into another by stating examples of the specified energy conversion correctly in at least three of the four cases. 09-Exc 19-1-1

Given a data table showing the water temperatures before and after each of four substances is dissolved in the water and asked to state whether the reaction is endothermic or exothermic, the student classifies the reaction as endothermic if the temperature drops and as exothermic if the temperature rises by so stating for each case. 09-Exc 19-2-1

Given that an ionic solid is dissolved in water and told the change in water temperature that occurs and asked to state the two processes involving energy which occur when a solid is dissolved in water and to tell which of the two involves the greater amount of energy, the student applies the concepts that the breaking apart of ions when an ionic substance dissolves in water is an endothermic process; that particles combining with the water molecules is an exothermic process; that if the endothermic 09-Exc 19-2-2

process is greater, the solution temperature drops; and that if the exothermic reaction is greater, the temperature rises, by stating the two processes and identifying which involves the greater amount of energy.

Given three procedures for preparing glassware for keeping fish and asked which is the best procedure and why the others are not as suitable, the student applies the concept that washing the glassware with tap water and then with distilled water leaves the fewest contaminants by selecting that procedure and explaining that the other procedures would mean leaving contamination. — 10-Core-1

Given a list of the chemicals used in the test for dissolved oxygen and asked what data he would collect to determine which of several samples contains the most dissolved oxygen and how he would use them to solve the problem, the student applies the procedure for determining the relative amounts of oxygen in water samples, comparing the total number of drops of $Na_2S_2O_3$ used in the Winkler test in each case, by stating in effect that he would count the number of drops of $Na_2S_2O_3$ added to each sample and compare the counts and that there is a direct relationship between the oxygen content of a sample and the amount of $Na_2S_2O_3$ required to remove the color. — 10-Core-2

When asked what he needs to know about a named substance to write an operational definition for it, the student recalls that an operational definition for a substance is a statement of how the substance may be detected by stating that he would need to know how to detect it. — 10-Core-3

When asked to open his book to Chapters 20 and 21 and to state an operational definition for *dissolved oxygen* (O_2), the student applies the concept of an operational definition and the information that O_2 is detected in a solution by adding Winkler solutions #1 and #2 and H_2SO_4 until the brown solid dissolves, then $Na_2S_2O_3$ solution until the color fades, then drops of starch solution, and then $Na_2S_2O_3$ solution until the sample is clear and that oxygen is measured as a function of the amount of $Na_2S_2O_3$ used by responding with at least a statement about how to detect dissolved oxygen. — 10-Core-4

Reminded that when he was studying the ICR's, oxygen (O_2), and carbon dioxide (CO_2), he was told in each case to cap the jars and asked why, the student generates the explanation that the lids are put onto the jars to insure that the variables -- the amounts of O_2 or CO_2 -- are altered only by the reactions in the fish and not by gas transferred into or from the water by stating the effect of the concept. — 10-Core-5

Given a description of Activities 20-6 through 20-11, including the results for the sample used as a control, and asked to give — 10-Core-6

term that is used to name the sample which serves as the control and why, since there is no change in the procedure used on that sample, it is necessary to do the reaction again with this activity, the student applies the concept that a control must be used with an experiment to rule out effects specific to the time of the trial (temperature, length of time, and so on) as causes of the results by responding with the term *control* and stating the essence of the concept.

10-Core-7 Given that several nonphotosynthesizing organisms are in a closed environment longer than several other nonphotosynthesizing organisms and asked which organisms will use more oxygen and release more carbon dioxide and to explain his answer, the student applies the concept that the longer an organism is in contact with a given environment, the more reactants it will use up for its survival and the more products will be formed by specifying the sample in which the oxygen level will be lower and the carbon dioxide level will be higher and stating that until the oxygen supply is exhausted or the organism dies, the oxygen level will drop and the carbon dioxide level will rise in a sealed environment in contact with living (nonphotosynthesizing) organisms.

10-Core-8 Given that a sample from a solution contains a specified dissolved gas and asked if all of the liquid contains the gas and to explain his answer, the student applies the concept that if a sample of a solution contains a specified substance, the rest of the solution also contains that substance by responding affirmatively and with the notion of the rule.

10-Core-9 Given a description of a situation in which the number of organisms is increased and asked what effect the increase in concentration will have on the rates of oxygen consumption and carbon dioxide production and why, the student applies the concept that an increase in the concentration of organisms, like an increase in any other reactant, increases the rates at which the reactants of a reaction are used and the products are produced by stating that the rates increase and the notion of the concept.

10-Core-10 Given that the fish in Chapter 21 are subjected only to slow changes in the temperature of the water in which they are kept and asked to explain why, the student generates the concept that fish are sensitive to sudden temperature changes by responding that a sudden change in temperature will be harmful to the fish and may cause their death.

10-Core-11 Given the water temperature of a lake in spring and in summer and asked what effect this change in temperature would have on how often a cold-blooded animal would need to surface for air and to

explain his answer, the student applies the rule that reaction rates vary with temperature by predicting that the animal would have to breathe more often in warmer water and stating the effect of the rule.

Given a list of four reactions and an "all of the above are correct" option and asked to select evidences that chemical reactions take place in living things, the student classifies the following as evidences that chemical reactions occur in living things: (1) some materials (reactants) are used up, (2) new materials (products) are formed, (3) concentrations are altered, (4) temperatures of living things alter the rate of new material formation, and (5) stomach acid is neutralized in definite quantities, as are other acids, by selecting all four of the evidences that occur in the check or the option "all of the above are correct." 10-Core-12

Given that a sample of the same product has been collected from a living and a nonliving system and asked to agree or disagree with the statement that the products can be distinguished and why, the student applies the concept that a chemical substance is the same whether it is produced by a living or a nonliving system by disagreeing with the position that samples from living and nonliving systems can be distinguished and stating the concept as the reason. 10-Core-13

Given a report that a specified motor runs because of a chemical reaction between a specified fuel and oxygen and asked, based on his knowledge of reactants in chemical reactions, to predict what should happen to the amount of fuel in the tank as the reaction takes place and why this happens, the student applies the concept that the reactants are consumed during a chemical reaction by predicting that the amount of fuel should decrease because the reactants are being consumed. 10-Core-14

Given a reaction from Chapter 20 or 21 and a statement of the position that a given amount of a specified reactant can react at different times with different amounts of another reactant and asked if he agrees or disagrees with the position and why, the student applies the concept that when chemicals react, they do so in definite numbers (ratios) and when all the particles have reacted, the reaction stops by stating that he disagrees with the position and the essence of the rule. 10-Core-15

Given that the oxygen (O_2) level goes down in water containing ICR's and asked what evidence he has to decide between the statements (1) that fish absorb and store O_2 and (2) that the absorbed 10-Core-16

	O_2 is involved in a reaction in the fish, the student applies the concept that in a chemical reaction, the particles are recombined in different ways by citing the decrease in the amount of uncombined O_2 and the production of CO_2 (a combination of O_2 and C) as evidence of a chemical reaction and stating that if the fish simply absorbed the oxygen, there would be a lowered oxygen level but the carbon dioxide level would remain unchanged.
10-Core-17	Given five statements to the effect either that the conclusions which can be drawn from the ICR activities prove something or that they suggest something about scientific models and asked to select the best statement, the student applies the concept that the results of scientific activities suggest or support conclusions or models, but they do not prove them, by selecting the entry which implies support for a model.
10-Core-18	Given the fact that the temperature of the human body doesn't drop, even on very cold days, and asked what the source of heat is in the human body, the student generates the concept that chemical reactions occur within the body that release heat and keep the human body temperature constant by responding to that effect.
10-Exc 21-1-1	Given a description of a situation in which differing air samples are stored in containers and asked how he would go about determining which container has the most oxygen, the student applies the concept that given a fixed reaction rate, the duration of a reaction is proportional to the amount of the reactants present by responding to the effect that he would invert each container over a burning object and find the amount of time it took for the flame to go out and the longer it took, the more oxygen in the container.
10-Exc 21-2-1	Given a pair of labeled axes and data about depths of water, variations in dissolved oxygen, and oxygen levels (in mg/l) needed for specified fish to survive and asked the lowest levels at which each species of fish could be found in the lake, the student applies the processes of graphing data and interpreting a graph by plotting the points, drawing a smooth line of best fit, and labeling the lowest levels at which each species of fish could exist, correctly for two of the three given species.

Given five glucose solutions whose different concentrations are indicated by their different colors after being tested with Benedict's solution and asked to place these in order of concentration from lowest to highest concentration, the student identifies the relative concentrations of the glucose solutions as the lightest having the lowest concentration and the darkest having the highest concentration by ordering the five solutions from the lightest to the darkest color intensity.	11-Core-1
Given the directions to get four samples of different concentrations of glucose solution and to test them according to the procedure in Activities 22-12 through 22-14 and asked to order the glucose content of the samples from the lowest to the highest, the student manipulates the four samples, Benedict's solution, and a hot water bath by ordering the solutions by concentration of glucose from the weakest and lightest in color to the strongest and darkest in color.	11-Core-2
Given that carbon dioxide is produced by a specified organism using the oxygen in the air and a list of possible sources of the carbon and asked to select from the list the source of the carbon, the student applies the concept that elements are not created, destroyed, or synthesized in chemical reactions, but are present in the reactants, and that food is a reactant for living things by selecting the option to the effect that the carbon is taken in in foods.	11-Core-3
Given the ratio of the size of the sample to the source and a diagram showing the number of individuals in a sample and asked how many individuals are in the source, the student applies the assumption that the number of individuals in the source is to the number of individuals in the sample as the size of the source is to the size of the sample by reporting the product of the number of individuals in the sample and the reciprocal of the ratio.	11-Core-4
Given that yeast and glucose react faster after grinding than before grinding even though the grinding kills the yeast and asked to explain why, the student generates an explanation to the effect that grinding frees the catalyst and allows the glucose to come into contact with it more easily by stating the effect of that explanation.	11-Core-5
Given that an organism grows and multiplies as it reacts and asked if the mass of the reactants is equal to the mass of the products and to explain his answer, the student applies the concept that the total mass in a reaction is constant and if the mass of living	11-Core-6

matter increases, the mass of the nonliving matter decreases by responding affirmatively and to the effect that the total mass is constant and that some of the glucose increases the mass of the yeasts.

11-Core-7 Given that a specific reaction needs a catalyst added to it when it occurs in a test tube, but not when it occurs in a living organism, and asked to explain the difference, the student applies the concept that living organisms supply their own catalysts to reactions by so stating.

11-Core-8 Given that a reaction takes place in his body at a much lower temperature than outside of his body and asked to explain, the student applies the concepts that he, like all living things, contains catalysts and that catalysts allow high reaction rates at lower temperatures than are otherwise possible by stating the essence of those concepts.

11-Core-9 Given that a specified reaction occurs in a living organism using catalysts produced by the organism and the claim that the catalyst will not function outside of the organism and asked if he agrees or disagrees and why, the student applies the concept that a catalyst which functions in a reaction within an organism will also function outside the organism if the catalyst and all the reactants are present by stating that he disagrees and the effect of the concept.

11-Core-10 When asked if he contains catalysts and to give evidence for his answer, the student classifies himself as containing catalysts and as evidence of his answer that chemical reactions take place at body temperature at faster rates than are possible without catalysts by stating that he contains catalysts and citing the appropriate evidence.

11-Core-11 When asked to list three variables which alter the rate of a reaction in living things, the student classifies temperature, concentration, and catalysts as altering the rates of reactions in living things by listing those.

11-Core-12 Given that several living and nonliving chemical systems are stored with all the materials necessary to reproduce themselves and asked how many systems -- fewer, the same number, or more -- will be present at a later time and to explain his answer, the student applies the concept that living chemical systems reproduce themselves, whereas nonliving ones do not by selecting the

responses which indicate that the same number of nonliving systems will be present and more living systems will be present after storage and stating the essence of the rule.

Given a quotation from an individual who has read Chapters 22 and 23 where the text warns against heating a living material containing a catalyst which is concerned in the reaction, including the statement that the reaction rate could have been increased by heating, and asked if he agrees or disagrees and why, the student applies the concept that most catalysts of living materials are destroyed by heat by disagreeing and stating the essence of the concept. 11-Core-13

Given a list of physical and chemical reactions, which includes burning of a material, and asked to select the chemical reaction involving oxygen as a reactant, the student classifies burning as a reaction involving oxygen as a reactant by selecting the reaction which mentions burning. 11-Core-14

When asked to state a definition for *kilocalorie* in terms of water, the student recalls the definition that one kilocalorie is the amount of heat necessary to raise the temperature of 1,000 grams (or 1,000 ml or 1 liter) of water 1°C by so stating. 11-Core-15

When asked to state a definition for *calorie* in terms of water, the student recalls the definition that a calorie is the amount of heat needed to increase the temperature of 1 gram (1 ml) of water 1°C by so responding. 11-Core-16

Given a computation of the amount of change in the heat energy of a specified amount of water in grams, resulting from a given change in temperature in °C, and five entries which purport to be answers to the computation, involving different units, one of which is *calories*, and asked which answer uses the correct unit of heat for the problem, the student classifies the calorie as the unit used to express heat when the measurements are made in grams and °C by selecting the response using that term. 11-Core-17

Given access to a specified quantity of water, a graduated cylinder, a thermometer, and an alcohol burner and a stand and asked to find the change in heat energy that results when a sample of water is heated for a specified time period, the student applies the formula for measuring the change in heat energy of the sample ($\Delta T \times$ grams of water = calories), carrying out the instructions given, by reporting the temperatures of the water before and after 11-Core-18

	heating and by calculating the calories of heat energy exchanged to within ±10% of the correct value indicated by the measurements he takes.
11-Core-19	Given the name and the symbol of a variable and asked what he would measure if he were asked to measure Δ *variable*, the student classifies the measurement of Δ *variable* as the measurement of a change in the variable by so stating.
11-Core-20	Given an initial and a final temperature of a mass of water and asked to find the amount of heat energy required for the temperature change, the student applies the formula (grams of water × ΔT = calories) for calculating the amount of heat involved in changing the temperature of water by computing the quantity of heat as the product of the appropriate quantities to within ±5%.
11-Core-21	Given a list of variables related to the cola-can calorimeter used in Chapter 24 and asked to identify which of the variables listed are important to the experimental results but are ignored, the student applies the concepts that a calorimeter measures the amount of heat released by a reaction and that variables which affect the amount of heat captured by the calorimeter are important by selecting both sources of heat loss listed in the question.
11-Core-22	Given a list of five variables, including the amount of matter, the duration of the heating, and the amount of heat supplied per time unit, and asked to select the variables which determine the amount of temperature change in an object being heated, the student classifies the amount of matter, the duration of heating, and the amount of heat supplied per time unit as the variables affecting the amount of temperature change of an object being heated by selecting only those.
11-Core-23	Given that humans take in chemical energy and asked to list three energy forms into which the body converts the chemical energy of food, the student classifies chemical energy as being converted into electrical, mechanical, chemical energy of other compounds, or heat energy in the body by listing any two of the forms of energy into which the body converts chemical energy.
11-Core-24	Given that a specific compound has a great deal of chemical energy stored in it and asked when it would release its chemical energy and what would happen to its particles, the student applies the concepts that the amount of chemical energy in a compound

changes during a chemical reaction and that in a reaction the particles of the reactants are recombined by responding to that effect.

When asked in what form energy is stored in a specific food, the student classifies chemical energy as the form in which energy is stored in food by so responding. 11-Core-25

When asked if humans are HCR's (human chemical reactors) and if so, to name three reactants and three products or if not, to state their energy source, the student classifies humans as chemical reactors, their input of oxygen, food, water, and so forth as reactants, and their output of perspiration, urine, heat, carbon dioxide, and solid wastes as products by responding affirmatively and naming those reactants and products although some of the products or reactants named may be replaced by suitable substitutes. 11-Core-26

When asked why glucose and yeast are included in a specified recipe, the student applies the concept that the yeast-glucose reaction causes dough to rise as a result of the formation of carbon dioxide by responding to the effect that glucose is used by yeast in forming carbon dioxide, the bubbles of which make the dough rise. 11-Exc 22-1-1

Given that a substance is being tested with starch and iodine solutions to determine if that substance is a catalyst which will break down starch and asked what he expects to observe if the substance is a catalyst, the student applies the principle that a chemical indicator is affected only by the presence of a specific substance and ceases to be affected when the substance is removed and the fact that iodine is an indicator which is blue-black in the presence of starch by responding that he would expect to see the blue-black color fade. 11-Exc 23-1-1

Given a specified mass of water, its initial temperature, and a lower final temperature and asked how many calories of heat the water has lost, the student applies the principle that the number of calories lost by water equals the mass of the water in grams times the temperature change in °C by responding with the correct answer determined by that formula. 11-Exc 24-1-1

Given a specified number of Calories (kilocalories) and asked how many grams of water could be raised 1°C by that many Calories, the student applies the concepts that a Calorie (kilocalorie) is 11-Exc 24-1-2

equal to 1,000 calories and that one calorie raises the temperature of one gram of water by 1°C by reporting the number of grams of water as 1,000 times the number of Calories.

Given any five of the sixteen assumptions of the particle model for matter and a selection of ten activities from *Probing the Natural World/2*, one or more of which are related to each given assumption, and asked to match each activity with the assumption of the model to which it is most closely related, the student classifies each activity listed from the text as being most closely related to that assumption in the particle model which it was used to develop, test, or illustrate an application of by matching each activity with the assumption of the model related to it, correctly for at least eight of the ten activities given.	12-Core-1